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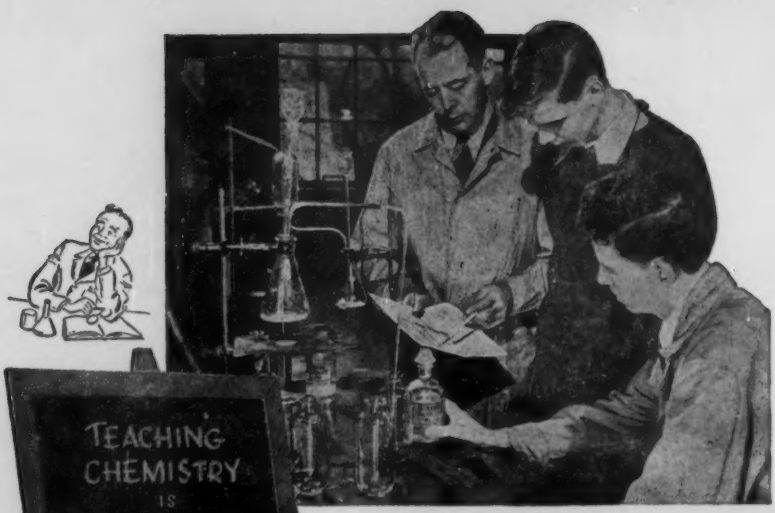
WORKSHOP FOR SCIENCE TEACHERS

VOLUME 35 APRIL, 1951 NUMBER 3



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SCIENCE EDUCATION

VOLUME 35 APRIL, 1951 NUMBER 3

THE EDUCATION OF TEACHERS IN SCIENCE

REPORT OF TWENTY-SEVENTH CONFERENCE, TEACHERS COLLEGE, COLUMBIA UNIVERSITY, NOVEMBER 1–4, 1950 *

THIS series of Conferences has, through the years, provided an opportunity for professional people of common interests to cooperate in the study of their work. The central concern has been the work of the science educator employed in the teachers college. Attention has been directed to such questions as, what is the proper professional function of the science educator, how may he educate himself for his work, and how may he carry on once he is on the job. In a very real sense the Conference has served a unique function in that its main purpose has been to offer to those of us interested in the education of science teachers an opportunity to study together and to discuss common problems.

In the planning for this Twenty-seventh Conference it was agreed that the questions to be discussed in lectures and in study groups should be those with which the participants are most directly concerned. Accordingly the membership was canvassed by mail and a list of questions was compiled from the replies. These were made available to all who were in attendance. The titles of the several study groups and of the lectures reflect the interests that were expressed in these questions.

THE THEME OF THE CONFERENCE

Presented by S. RALPH POWERS, *Teachers College, Columbia University.*

Education is often spoken of as a force in improving community life and community living. This relationship or function may be thought of as furnishing the theme of the meeting. It was recognized in many of the questions that came in response to the canvass. In this point of view the "good community" is one in which there is increasingly rich opportunity for all its members to realize both their biological and their culturally determined desires. The traditions of the democratic society support the conviction that people shall enjoy free play of the mind and freedom to work together toward these ends. Young people, as they mature, will become increasingly involved in the work of the community. It is a function of the teacher to help them in this process of maturing. Learning is then to be thought of as a community activity, a process in which the learner enters into some kind of action with elements in his surroundings. Three centers of interest, which are closely interwoven, were recognized in planning the lectures and the discussion groups of this Conference. These are the community, the young people, and current problems.

THE COMMUNITY

There is widespread agreement that first-hand experience is basic to effective learning. The idea is not new; indeed a central thought in American education is that schools shall educate for community living. The teacher is challenged to help young people plan their lives and gain the understandings and skills that will enable them to live well in their community. The suc-

* Edited for the Conference by Theresa J. Lammers, State Teachers College, Westfield, Mass.

cessful teacher will be informed about the unique features of his community, the difficulties in providing food, shelter, work, education and recreation, and its relations with other communities including the rest of the world. He will be challenged by a desire to do his share as an adult to make his immediate community a better place in which to live.

Every community is unique in that its qualities are determined by its physical and biological features, the cultural heritage of its people, and by other variable factors. At the same time communities are similar in that, in America (as in other nations), they are the products of similar national, religious and ethical ideals, and traditions. Communities are relatively stable in that young people generally expect to grow up, marry, establish their homes, and work in the region where they were born and went to school. Thus the controlling ideals and traditions are passed on from one generation to the next. One may think of the function of the school as to help young people appreciate the traditions of the past and at the same time help them to adjust to necessary changes and also to direct the course of changes in accordance with their own concepts of the "good community."

Teachers must introduce their studies of community while working in the schoolroom situation in which they are employed. In many instances the school architecture and the school organization have not been planned with recognition of the activities in which the teacher wishes to engage, and adaptations must be made. In practice, teachers do introduce studies of community as enrichment materials in topics or courses regularly a part of their work or they may introduce new units and new studies centered directly on matters of immediate concern. The general nature of work actually undertaken may be seen by brief reference to a few illustrations.*

In a highly industrialized community a teacher of chemistry, with her students, studied the industries, learning about kinds of raw material brought into the city, the industrial processes employed in fashioning the raw material into useful products, and their distribution within their own and other communities.

In a course in biology in a small eastern city the class studied plant and animal communities, the conditions necessary for successful community development and the kinds of plant and animal communities that had developed and that were developing within the particular region. In this instance the students thought back into prehistoric time about the origins of the soil and the conditions of climate that made possible the growth of the forests from which the wealth of the community had been derived. In their studies of the total community they learned how the forests had been cleared, and raised questions about how, in the light of modern science, these forests might have been conserved for continuous production. In their studies of plant succession and the prevailing conditions of climate the students tried to envisage the processes by which the remaining forests could be maintained on an increasingly productive basis.

In a highly industrialized community the school nurse, through visits and interviews, discovered the chronic illnesses among older people in the families of high school students. She found that many students assisted in the care of relatives with chronic illnesses and this led to instruction in home nursing related to these findings. In cooperation with the teacher of biology practical work was given on diets, circulation, respiration, excretion, posture, and communicable diseases.

In another illustration, this one in a pri-

* Most of the descriptions are adapted from *New Directions in Science Teaching*. A Report of a Cooperative Project in Seventeen Secondary Schools with the Bureau of Educational Research in Science, Teachers College, Columbia University. By A. D. Laton and S. R. Powers. Copyright, 1949. McGraw-Hill Book Company, Inc., New York.

vate secondary school, teachers of science and social studies worked together helping their students to gain a comprehensive view of the interchange of material and energy throughout the world, recognizing that this interchange is the basis for our industrial economy.

THE YOUNG PEOPLE

When attention is centered upon learning as an active process that goes on in the mind of a learner, it is obviously essential that we shall be informed about the young people with whom we work. As they study their students, teachers will discover variation in intellectual development, in the extent to which they have enjoyed cultural opportunities, and in their interests. They will make effective recognition of these variations as they learn (1) to adapt reading materials to reading abilities, (2) to explore vocational interests and relate them to vocational opportunities, (3) to encourage special studies in agreement with special interests, (4) to help young people experience life situations to give meaning to verbalizations, (5) to help those with narrower interests and backgrounds to see their everyday activities in relation to broader meanings, and (6) in general to help them achieve a direction in their maturing that they can recognize as in agreement with the responsibilities to the community they will wish to accept. The manner in which these and other variations among young people have been recognized in practice are suggested in illustrations.

In a large mid-western city studies were undertaken in cooperation with students to discover their opinions about what were important community problems. Their questions and their discussions in groups and in personal interviews indicated that students were interested in learning about health care, the necessities of a simple home, marketing, inexpensive recreation, religion in marriage, sex relations and parenthood, desirable size of family, divorce, and living with in-laws. The teacher commented: "One of the most important results of these studies was more sympathetic understanding by the teachers of their students as human beings, with homes, families, financial problems, hobbies, church affiliations, and the hundred and one other personal characteristics that add richness to our contacts with other people, whether they be old or young."

In a public high school, in which there had been considerable emphasis on preparation for college, the teacher of biology accepted an assignment to work with students who wished to follow other interests. In preparation for his work the teacher made careful studies of student personnel cards. From these he learned about students' family backgrounds, their interests, intelligence, health, aptitude and other details. The school had kept excellent records. Working from this background of information, and in cooperation with his students, the teacher planned a one-year program of study "designed to include only material that the student could apply to understanding and facilitating their own development, in developing their own philosophies, or in understanding the society in which they live and its problems." The guiding theme of the course was: "Health a personal and social problem." The work was done largely through committees with groups giving reports and demonstrations to the class. They gained a conviction that the work they were doing was important to them personally and therefore entered seriously into the effort. The results were rewarding and the opinion was expressed that this "non-college preparatory group" was doing "careful, individual thinking at a level not often found even in classes made up of very bright students."

CURRENT PROBLEMS

In experiences such as the foregoing, teachers and students were working together on matters of real concern. It was recognized at once that in situations such

as these *"teachers will teach better if, at their own adult level they have grappled with the common problems of people living in our democracy, have become acquainted with the controversial issues for which present knowledge is inadequate with respect to both what we know and what we do not know."* In the study of current problems the science teacher's interest is extended beyond the field of his specialization. The scope of a controversial issue is determined by its setting in the community and not by the boundaries of special areas of study.

Illustrations of studies carried on by teachers working together on the adult level included many questions of detail about human beings. The concept of human life span suggested an organization for the mass of related details. It was observed that almost all these studies required consideration of the ages of the individuals and their progress toward maturity. This concept suggested an organization of learning that gave perspective on life as a whole.

There is throughout the world an ever-present interest in questions about intercultural relations. In studies actually undertaken the genetic differences among people were carefully examined. The participation by people of unusual competence, both white and colored, in these studies contributed much to the clarification of issues within current controversies.

These studies of current issues were inclusive of studies of the community and of young people. Issues are necessarily set in the lives of people and in the communities in which they live. The same issues recognized by the teachers as they worked together as adults would surely be recognized as they worked realistically with young people. For example, studies of production, distribution and wealth led the teachers into better understanding of how teaching about natural resources and human beings could be made to contribute to better community attack on the problems of food, shelter, clothing, health, conservation of our material wealth, and occupational opportunities.

In another illustration a group of cooperating teachers directed their attention to changing concepts of time, space and the structure of the universe, and to the disturbing effects of these changes on people's general orientation in life. Working with their classes these teachers made studies to discover the ideas about the physical world that young people held and that caused them concern. Teaching was then directed toward helping young people to resolve their conflicts and to develop for themselves a consistent and acceptable world view.

Teachers are challenged, as they gain confidence in themselves, to relate materials and methods more directly to the activities and interests in individual communities, individual classes, and individual boys and girls. This can be done by teachers in service who are studying their communities and young people and giving thought to the meaning of their work as teachers in the specific situations in which they are employed.

In the illustrations to which reference has been made the teachers, according to their own testimony, made many changes in their ways of thinking about their work and in the practices they followed. Specifically these teachers learned and applied new techniques for studying communities and children; explored new fields of science and ventured into other fields than science where they felt less at home and often frustrated by their lack of knowledge; planned and gathered new teaching material; learned new evaluation techniques and constructed new instruments; and in doing these things they worked with enthusiasm, following the drive that comes from professional interest and that affords personal satisfaction.

Departmentalized thinking and administrative inflexibility were powerful in the traditions of the schools to which references have been made just as in others. It is

undoubtedly for this reason that educational theory adaptable to the purposes guiding the work of these teachers found most common application in non-academic or non-college preparatory classes. It seems appropriate to conclude from these and other observations that all students will do "careful individual thinking" when they are given opportunity to think about matters that come within their experience and that they recognize, at their own level of maturity, as significant to them.

New directives for science education are emerging. The characteristic feature in the new is the increased emphasis on studies of young people, their communities, and of current issues as a means of determining the kinds of learning experiences to be introduced into the curriculum. The teacher will think of his students as young people maturing in the community of their homes and their school. He will see them working continually with the tasks that seem to them necessary to their own biologically and culturally determined needs and desires. The work of the teacher is to help them deal with the tasks that arise in the course of their maturing. In the newer emphasis, criteria for the choice of learning experiences will be defined with less concern for the logic of organized subject matter and with more concern for the recognized needs of young people.

It was recognized in the discussions of this Conference that the science educator must give more attention to the encouragement of new competencies and a new kind of literacy. Science teachers have given much of their time to gaining "literacy" in science and have given too little time to studies of children and their communities, and to the issues with which the young people are faced and concerning which they must make decisions.

It was further recognized in the discussions that these new competencies can hardly be learned through the usual experiences of classroom teaching. In the nature of things there is in the schools strong pressure to follow traditional practices and in this situation the experienced teacher may be one who is "practiced in errors." There is an abundant and carefully tested literature on growth and development and on related matters just as there is about physical and about biological science. Neither can be learned and used except through carefully planned effort.

It becomes clear that, if these new trends are to be followed successfully, there must be a new statement of the nature of the teacher's work—one in which the teacher himself will be encouraged to assume a larger responsibility in laying out his own work. Other matters, heritages of the past, will require careful examination by professional workers.

Some questions suggested for discussion in the study groups of this Conference include the following:

1. What measures may be undertaken in professional education to help teachers gain for themselves the confidence that is necessary for successful work with children and young people?

2. How may teachers in their present assignments (to special subjects) work effectively in the performance of the responsibilities they have themselves accepted as proper?

3. What changes in our own teaching practices seem necessary if we are to help young people accept a measure of responsibility for the work of the community and help them to derive greater satisfactions from living there?

4. What can be done through professional education that will help teachers to discern qualities of personality in their students and to work with them on a friendly and cooperative basis?

5. May we expect that all students will do "careful individual thinking" when they are encouraged to think about matters recognized by them, at their level of maturity, as of immediate personal concern?

6. What kinds of professional materials will be helpful to teachers who are trying

to relate their work to issues and problems which are of immediate concern to the young people with whom they work?

7. What economies in science teacher education may be accomplished to allow time for teachers to gain competence in important areas, such as community growth and development, that have in traditional practices been largely neglected?

* * * * * *

(Following the opening session and introduction of the theme of the Conference along the lines of the foregoing discussion, seven study groups were formed. They met for five sessions, each one and one-half to two hours in length. These meetings were greatly stimulated by the important addresses and the social gatherings that were interspersed throughout the four day session. Each group had an opportunity to present a summary before the full Conference. Animated discussion always ensued for as much time as could be allowed. The following seven reports are limited to selected phases of the deliberations of the several study groups.—ED.)

* * * * * *

STUDY GROUP A: *Science in Childhood Education*

Reported by ROSE LAMMEL, *New York University*, and PAUL BLACKWOOD, *U. S. Office of Education.*

The development of a good program of science in the elementary school depends on a growing understanding by all teachers, supervisors, and administrators of the purposes of the elementary school and the way in which science experiences can contribute to these purposes. An increasing understanding of the way children learn, what their interests are, how they solve problems, is needed. The planning and the use of curriculum experiences must be in terms of our purposes and in terms of the best we know about the needs of children. These are imperative considerations for both the pre-service and in-service education of teachers.

Any group of teachers wishing to improve the science program must constantly bear in mind the major purposes to be served through the use of science experiences. Recognizing, selecting, and organizing appropriate questions and problems, and the development of appropriate ways of working with children so as to help them develop problem-solving skills and constructive attitudes toward their natural environment depend upon insight into the over-all purposes. In addition, teachers must be continuously evaluating their methods of working with children and evaluating the effects on children of the science experiences they are having.

As teachers explore the purposes, various ways of organizing science learning experiences, and the methods of evaluating the effects of such experiences, a great range of other questions will come to the fore. Some of the more common and important ones are: How do you recognize science leads? How do you follow up on the science leads you discover? How can the teacher continually build up a workable background of pertinent information? How can we provide for individual differences of children? Who determines what the program should be? What is the relation of a written program or science guide to what goes on in the classroom? What should be the background of the science supervisor or coordinator?

As groups of teachers explore the foregoing and other questions, as they develop their own science programs, they may find the following considerations helpful:

Purposes of Science Experiences in the Elementary School

1. To help children interpret and understand their natural environment and to solve problems related to it.
2. To help children develop skills for solving problems and for answering their own questions.

There are many other purposes implied in these two statements. Careful and con-

tinuous recognition of these two purposes will modify the selection of the problems and the appropriate content as well as the methods of working with the children.

Selecting and Organizing Materials and Experiences for Learning Science

The planning of a program of science experiences for a given school should involve as many of the teachers as possible. Such participation is an important aspect of in-service education and will improve and enrich the science teaching in the school greatly. The elementary science program needs to be planned so that children will have an opportunity to work on problems real to them. The interests, questions, needs, and the persistent problems of children in their community should be sources from which the series of problems, topics or areas developed for study should be derived.

The curriculum guide or science resource materials need to suggest aspects of the problems selected that seem appropriate for consideration by children at different levels of maturation. A rich supply of suggested learning experiences should be included. In fact, good science curriculum guides will contain such a multitude of suggested activities that it becomes necessary for each teacher and the children to select judiciously the experiences which most nearly meet their needs. A number of useful guides have included examples written by teachers of problems studied and experiences engaged in by the children. Other teachers benefit from the sharing of these illustrations. Frequent suggestions as to *how* children might be involved in planning and in solving problems would help sensitize teachers to the importance of methods used and to the potentially greater learnings when children are involved in all phases of the learning process.

Evaluating Our Ways of Working With Children in Science

Since the major purposes of education can be achieved only if good methods of problem solving are employed by the children and the teacher, the teacher needs to be clear about how she works with children. In evaluating her work with children in science, she needs to consider such questions as: Do I provide opportunities for children to identify and discuss questions of importance to them? Do children help plan the science experiences? Do I help children use a variety of ways to find answers to their questions? Do I provide a variety of ways for children to find answers to their questions? Do individual children use a variety of ways in answering questions? Do I tie the science experiences with the purposes of the total elementary program? Do I give children an opportunity to think? Do I encourage children to be creative (speculative, reflective) in considering problems of importance to them? Are there opportunities for children to compare their conclusions with those of authorities? Do I use science experiences to help develop important skills of writing, reading, communication, and the like? Do I always help children see the reasons for doing experiments and to see the connection between the activities and what we are trying to learn?

Some Suggestions For In-Service Help in Science Teaching

Teachers have been helped to improve their science teaching in many different ways. In view of the common acceptance of the principle that learners should have many and varied experiences in studying problems in science, the good in-service programs will provide many and varied experiences in science for the teachers. The best in-service programs are based on the needs and the problems of the teachers concerned. A few suggestions for ways of working are included here:

1. Numerous experiences could be planned with teachers to aid in developing a broader understanding of the culture so that they can operate as well-informed adults in their community. These opportunities for teachers to identify and to study

problems on an adult level can help them to experience the satisfaction that comes from "seeing a problem through." Trips of various kinds to learn about the resources of the area will help teachers become sensitive to resources which their pupils may use.

2. Workshops planned by and for the teachers of a building or for teachers of a small number of schools can be very successful in helping teachers gain competence in guiding learning experiences in science. Many first-hand experiences in working with experiments, demonstrations, excursions, using visual aids, science activities of all sorts must be available to the teachers.

3. For staff meetings or workshop centers, examples could be brought in of ways children have found answers, ways they recorded their work (such as charts, models, etc.). Collections showing the variety of things children have made and science exhibits which have a definite purpose could be shared.

4. Teachers, supervisor, and principals could consider together illustrations and descriptions of how others have worked out science problems with children. Consideration of how groups began to study problems of their environment, where and how children found information to help on the problems, actual reference and source materials used, outcomes that were evident would all have a part in stimulating more and better science teaching.

5. Consultants and outside speakers are helpful if their contributions are geared into the purposes and plans of a school staff.

6. Opportunities for teachers to visit other classrooms where science teaching is going on could be provided.

7. Teacher-teacher interviews could be arranged to discuss such questions as: How did you get your science program started? How did you get children involved in the program? What were some of the things you found most successful?

8. A school staff could work together to build up the science teaching resources in a school. The compilations of ready sources of films, slides, filmstrips, usable experiments and activities, as well as available community resources for learning in science would be useful.

9. In a school staff, ways for an experienced and enthusiastic teacher to give assistance and leadership to other teachers in developing a science program could be worked out.

STUDY GROUP B: *Science and Regional Study*

Reported by JULIAN GREENLEE, *Western Michigan College of Education, Kalamazoo, Michigan.*

This study group included science supervisors, general supervisors, science teachers, elementary classroom teachers, professional scientists, college students, and heads of science departments. Despite the wide range in professional interests, there seemed a unanimity of opinion as to what the schools should be doing and as to what are generally desirable procedures for doing it. The members of the group were much pleased with the progress being made in many parts of the country.

Regional studies seem to represent an appropriate part of the instructional program for people at all age levels. Of course, the type of studies to be undertaken vary with different age groups and with different communities. They should help the pupils to see each environment as a part of a larger one, that each of the different aspects of the region is interrelated with all of the others, and that what is done in one part of the community has an effect on all of the other parts. Regional studies help to develop a concern for and an interest in the problems of others. Participants come to see the interrelationships between situations that they face and those faced by people in other regions. Such understandings may bring an awareness of and insight into state, national, and international problems.

A region for any group, may be thought of as an area with common problems and common resources for solving them. The region of concern to an individual increases in size as he matures. Thus a region for a small child is much more limited than one for an older person. Regional studies should deal with phases of community life that are important to the persons involved. They should help the individual get information and understandings that will enable him to deal more satisfactorily with the problems in his environment. There are, too, many possibilities for constructive action in regional studies for the time of the pupils and the teacher to be taken up with mere busy work.

The school should increase the competence of the community to deal with its problems. Any issue that is of concern to the community should concern and affect the instructional program of the school. Examples of situations in which a community was sensitized to a vital problem, as a result of a regional study by the school, were discussed. For example, the people in a coal mining town were generally unaware of the implications of the fact that the coal would be depleted within a period of ten years. This was of more concern to the youth planning their future relation to the community than to the older residents. The facilities of the school should be directed toward making an attempt at discovering other resources so that this region which is a home to many people may still be productive rather than becoming a "ghost community." In other cases the parents in a community have taken needed action after the children became aware of possible solutions to bad situations. Some schools find children to be very effective help in getting and maintaining good school-community relations.

Teachers colleges have many responsibilities in connection with regional studies. The staff of such an institution should be able to assume leadership in helping the people of the region to become aware of its potentialities and limitations. They should be concerned with helping to develop the possibilities and overcome the difficulties. Regional studies may sensitize the staff and the community to problems as well as opportunities which are vital but unrecognized. Teachers college personnel should understand the environment from which their students come if they are to help them get the understanding needed in controlling that environment. Prospective teachers should participate in studies of a community and/or region if they are to help their pupils with that type of activity.

Teachers colleges should provide their students with opportunities to live with the types of procedures that they will need, both in the classroom and as members of the adult society of which they will be a part. They need to have experiences in which they can see the advantages of intelligent group action. It seems that as man advances in his ability to control the materials of his environment he becomes more dependent on the resourceful cooperation of his fellow man. The fruits of a complex civilization can be enjoyed only on a group basis. Regional studies offer an opportunity for the practice of democratic procedures. Participation, by the members of the classroom group, in all phases of the planning and execution of an enterprise is prerequisite to its satisfactory completion.

An ability to help people carry on a regional study presupposes an understanding of the people with whom one works. Only the teacher who is concerned for and understands children of a given age can effectively help them in planning and carrying on this type of activity. While this understanding is necessary to the successful completion of a regional study, the study itself represents one effective way of getting it. Teachers get a better understanding of the pupils as they become acquainted with the community in which they live. Through such a study the classroom group becomes involved in all of the aspects of community living. Traditional

barriers between the pupils and the teacher cease to exist. Each person in the group becomes important to each of the others as they work toward a common goal that, to them, is significant.

STUDY GROUP C: *Science from the Developmental Point of View*

Reported by MERVIN E. OAKES, *Queens College, Flushing, New York.*

In accordance with general consensus, chief focus of attention in Group C was "Concept-Formation by Children." Help was obtained by summary of the section, "Child Development," pp. 137–197, *Encyclopedia of Educational Research,* edited by Walter S. Monroe, The Macmillan Company, revised edition, 1950, particularly the part dealing with "Concepts."

On the first day of the Conference the luncheon address, "The Field Theory Approach to Learning" by Professor L. Thomas Hopkins, exerted great influence in the discussions of Group C. Its impact was repeatedly felt. The general question "What is the nature and development of children?" became the more practical one "How can teachers help a child extent his psychological field as related to those of his needs which are answerable by science?"

How Are Concepts Formed by Children?

In pursuance of this question much attention was devoted to analysis of anecdotal records of children's behavior and reports of personal experiences presented by Mary E. Jones (Montgomery County, Md.), Helen Trask (Munsey Park, Long Island), Robert G. Williamson (Wilson Teachers College, Washington, D. C.) and others. Joy Kantor (graduate student, Teachers College, Columbia University) told of a feeding experiment with rats in a public school in New York City where tooth decay was prevalent. The need for better diet, especially milk, was convincing to both pupils and parents.

A teacher in Buffalo, New York, following a class discussion of plants and animals, received a note from a child's father saying "I am not an animal! And that's final." Two or three in our group pointed out that a child must be helped to see that the question is not: Who is right? but: How does one gain information? How does one reach conclusions based on reliable observations? Majority opinion is not a means of establishing truth. Similar procedure was suggested when a child in a rural school states the familiar belief that thick fur on a squirrel in the fall foretells a long cold winter. How many squirrels were observed? For how many years were accurate records kept on which to base this conclusion? Children's concepts vary with the community in which they live.

A constantly recurring question was: What is authority? A child tends to quote parents, or teacher, or printed word as authority. We should help him early to recognize that the printed page is a form of communication from one person to another. The term "authority" should not be personalized. The method by which information is gained is the important consideration. An authority is the best source we have available for information.

Facilitating Concept Formation

Another main thread in every discussion session was: How can teachers help a child in concept formation?

For one thing, it takes time. The self is constantly reorganizing its field (Hopkins). Children must be given opportunity to organize their learnings. Each must be helped to take stock of himself. Vocabulary needs to be reorganized frequently. Teachers, however, need to be alert not to destroy a child's security. His insecurity may arise from a "block" gotten in the home and then confronted with conflicting ideas at school. Fluidity (expecting change) is the greatest help to security. There is security in change. If change requires more energy than the organism can produce, there will be resulting insecurity. Developmental adjustment is a

continuous process from the cradle to the grave. Security varies greatly in different cultures.

Concept formation is also advanced by a permissive atmosphere in the school situation. Encourage questioning, including teacher's opinions and statements. Respect a child's opinions and searchings. Encourage him to identify and to formulate problems. Allow him to propose methods for seeking answers. Give him a chance to formulate hypotheses and to act on them. It often helps to let a child verbalize. For instance, when loud, sizzling sounds had been heard, an eight year old boy suggested, "Could it be a meteorite?" Sometimes it is best that the adult *not* say anything; sometimes verbalization by the adult at the right time is very useful.

Taking advantage of children's previous experiences is another means of aiding the process of gaining concepts. Thus readiness is taken into account.

To observe, to experiment, to manipulate—thus to gain experience—form the bases for real concepts. Good teaching continually enlarges the environment for children. It is the teacher's responsibility to open up many areas and expose children to many experiences. An experience may not all be within the child's range but he will pick out what is useful to him. Children learn only what they accept (Hopkins).

"Concept Formation in Science Education," the address by Aaron Stern at the final session of the entire Conference, was seen to constitute a part of the work of Group C. "All of us need techniques of concept formation" he said. Concepts are largely meaningless without concrete experience; therefore the curriculum must be rich in activities. Science is more than a reservoir of knowledge: it is a way of life. It is to help us understand similarities among seeming dissimilarities. These abstractions are generalizations. Language or communication is also concept formation, that is to say, a form of abstraction. Understanding or meanings should be within the experience level of a child. Misconceptions are related to personality, that is, to attitudes. Stern cited the work of Kurt Lewin which shows that both for developing concepts and for changing attitudes, the best means is the interaction of group discussion. Interpretation thus best develops in and by the child.

CURRICULUM IMPLICATIONS

Both Group C and Stern included consideration of curriculum. The aim of the curriculum is concept formation—the dynamics of understanding (Stern). There is no one grade placement for specific material. Group C agreed that teachers should make it a practice to keep more anecdotal records of the concept forming procedure as it actually takes place in the classroom. Many more such reports should be available for exchange among teachers. Another responsibility of teachers is to interpret the development of concepts to parents. The kind of thinking that children do can be improved. Adults need to consider the thought processes that children go through.

SUMMARY

1. There are many factors which facilitate concept formation.
2. Concepts develop from concrete to abstract.
3. Concepts are closely related to attitudes.
4. Concepts are best developed by group discussion.
5. Science in childhood education (learning) is probably a more acceptable term than teaching of science.

STUDY GROUP D: *Science in Early Adolescent Education*

Reported by WILLARD JACOBSON, *Teachers College, Columbia University.*

What kind of preparation should a science teacher who is concerned with early adolescent education have? Very early in

its discussion, the group was faced with this central question. In general, we tackled this problem by trying to get a picture of what a good science teacher does as he works with young adolescents.

1. The teacher of science for early adolescents must know himself and the young people with whom he works. As soon as he begins to prepare for teaching, he should have many opportunities to learn about young people. He may work in summer camps, assist in scouting and church clubs, participate in planned observation of children in classrooms and he should have an opportunity to take an active part in various school activities. In a teachers college, he should have the opportunity to make a more intensive and extensive study of adolescent psychology and child development. Student teaching should be required. An attempt should be made to make this experience as near as possible to an actual teaching experience.

2. A teacher of science should *know how to determine what should be taught.* Too often, a fledgling teacher never has had experience in doing this. A teacher should become familiar with the problems and interests of the young people with whom he works, their parents and their comcommunity. He should also recall his own personal problems and experiences. Often these problems are interrelated. For instance, a community may have a general housing problem. The parents, however, probably are interested in housing in order to have a better home in which the family may live. The young adolescent's housing problem may be centered around his desire for a room or science laboratory of his own. Needless to say, it is a rare teacher who does not have his own peculiar housing problem. These may be some of the interests to which a teacher should turn in order to determine what he should teach. A student teacher should have a chance to look at these four sources and help to choose what should be taught.

3. A science teacher should know how to plan with children and help them carry out those plans, and he should have experiences in the teachers college which will help him to do this. None of this can be done unless there is a feeling of permissiveness in the classroom situation. The adolescent should be freed of the constant threat that he may be ruined by marks and examinations. He must have the freedom to make mistakes and to correct them.

4. The science teacher should know how to help adolescents to minimize fruitless experiences in the areas which are necessary for useful living. He should, for example, try to help the student achieve satisfactory human relationships. He should certainly try to help him not to become ill. Of course, the young person may fail at times. He should be helped to view and think through his failure intelligently so that his experience of failure will lead to future success and an intelligent awareness of his limits.

5. The teacher must have certain abilities: (1) At the minimum, he should know the subject matter and techniques which his students may be expected to know after they have worked in his classes. (2) He should know something concerning the routine of a day's work in the classroom where he may be called on to act not only as teacher but also as clerk, guardian, moderator, companion and even umpire. (3) He should also know how to work with children, their parents and his colleagues in obtaining, devising and improvising the materials they need to do the things they will be doing. (4) A teacher should be able to communicate well through various media. For example, he should be able to speak logically and clearly, use the blackboard and operate a motion picture projector, slide projector, and typewriter. (5) He should be able to listen intelligently. (6) The science teacher, especially, should be able to operate the equipment that his students will have to handle.

6. The teacher should be free from certain *limiting* physical and behavioral characteristics. For example, an inability to like children individually and in groups,

the possession of certain physical handicaps such as epilepsy and deep psychological conflicts or neuroses are limiting factors. It was felt that the teachers college had a responsibility in helping to eliminate those limiting factors that can be removed or else direct the student away from teaching as a career.

7. The teacher should know how to help young people evaluate the success of their educational experiences. Concerning the experience that was planned: Was it done? Was it done satisfactorily? Was it worthwhile?

This type of teacher has to be trained, and the teachers college must take the responsibility for this training. The teachers college should be willing and able to certify that its graduates are qualified to walk into a classroom and work successfully with children. This will require a new and better education for the teachers of science.

1. The teacher training program should be extended to six years. This should include four years of undergraduate preparation including student teaching and increased opportunities for working with young people in the public schools. At the end of this period, the student should be given a temporary teaching certificate and sent out for a year of supervised internship, with pay, in an actual teaching situation. After this internship, he should have a year of graduate study.

2. The special problem of science supervision was recognized. It was felt that persons who will supervise science teachers should receive special training for this task to enable them to understand and help with the problems that face science teachers.

3. Science teachers in teachers colleges should critically examine the methods and content of their courses in light of the purposes and objectives that are professed.

Education thrives in some atmospheres and shrivels in others. We must strive on the one hand to create in schools through enlightened supervision, administration, and organization an atmosphere of academic freedom. On the other hand, we must train teachers who will recognize the opportunities and responsibilities that are involved with this freedom. We were in general agreement with the thesis that, for the successful education of adolescents and teachers of adolescents, we must strive to assure these four freedoms for science teachers:

Freedom for self expression
Freedom for self improvement
Freedom from autocratic supervision
Freedom from want of equipment

STUDY GROUP E: *Science in Secondary Education*

Reported by J. Ned Bryan, *College Entrance Examination Board, New York, New York.*

Educators, especially those who "teach the teachers," have a professional and moral obligation to study, to interpret, and to constantly advocate improvement in the educational opportunities provided in their culture. Science plays a particularly cogent part in our culture and as an educational area it deserves the most careful consideration.

The secondary school student in our culture can be characterized as one who most certainly will be a taxpayer, should become a voter, may become a parent, and may become, at least for a time, a member of the armed forces. The probabilities are that he will not be a technician, and there is only a slight chance that he will be a research scientist.

The secondary school student in our culture lives in an environment in which the impact of scientific information and concepts plays a major role in determining his behavior. Scientific farming, antibiotics, and the jet plane are indicative of the specific applications of science in a rapidly changing culture. Although the student will not, in all probability, become a research scientist, he should be cognizant of, and sympathetic with the role of the scientist in our culture. He should become increasingly aware of both a historical and an intellectual perspective in science.

Science should help the secondary school student make sense out of his environment. Science should help him become aware of his heritage—the body of information, and the methods provided for the solution of problems. He should deal with problems that are his problems. He should be fully aware that categories of information are man-made—that scientific concepts are subject to change. When his actions, as the result of his findings, are acceptable to him, and to the society of which he is a part, or when his actions advance the culture, then the solutions to his problems are meaningful.

Considering the secondary school student and his environment one becomes aware that goals for science teaching in the secondary school imply a need for both implementation and evaluation. The statements which follow deal solely with goals but they are the considered opinions of a group of science educators and as such may prove fruitful for further consideration. They are in no sense exhaustive nor do they represent unanimous opinions but they represent a way of thinking which may lead to an improvement in the educational opportunities provided in secondary school science.

I. Science in secondary education should help the student achieve an understanding that scientific concepts are always subject to change. First, the acceptance of absolutes by the general populace has often been a block to scientific and social progress. For example, many are prone to accept race as an absolute fact and conclude that social and political stratification is an inevitable result. Clearly it can be shown that race is merely a convenient category with no such implications. Second, new categories may completely alter concepts. The change from the geocentric to the heliocentric view of the world profoundly affected social thinking within the culture as well as the scientific approach to the study of the cosmos. Third, new instruments may provide new or more accurate evidence which may change existing concepts. The student should become increasingly aware that he lives along a scientific continuum.

II. Science in secondary education should help the student achieve the attitudes that characterize scientific investigation. First, scientific honesty is the prime requisite of scientific investigation. The student should never seek predetermined outcomes. Many of the "lab" and "demonstration" experiments in use not only encourage predetermined outcomes but lead to "fudging" on the part of both student and teacher. The student should learn to regulate his own behavior in terms of scientific honesty. Second, judgments are reserved, in scientific investigation, until sufficient data are available for valid inferences. The student should never generalize from a single observation. He should recognize the limits of accuracy in observation and the meaningfulness of "significant figures." Third, scientific investigation precludes authoritarianism. The student should be encouraged to accept only those authorities which he recognizes on the basis of his own experience—real or vicarious. He should reserve the right to reject any previously accepted authority on the basis of further experience, and the right to accept new authorities on the same basis. Fourth, scientific investigation demands the right of free inquiry, within an accepted framework of reason. A law passed by the New York Legislature in 1950 (Sec. 324, Chapter 135, subdivision 5) indicates that free inquiry is not universally accepted.

". . . a pupil may be excused from such studies of health and hygiene as conflicts with the religion of his parents or guardian. . . ."

Officials of the New York Department of Education in compliance with this law sent a directive dated Aug. 11, 1950, and signed by Lewis A. Wilson, Acting Commissioner of Education, to superintendents and principals which included the following:

"The Commissioner of Education has approved the exemption of the children of parents or guardians of this faith from instruction in the units on *Disease Prevention and Control* and three other specified areas. . . ."

"Required sections of the Regent's examinations as well as the State Scholarship examination will be constructed so as not to penalize pupils who have been excused from instruction in the specified units of study."

III. Science in secondary education should help the student achieve a realization that technological developments may make highly specialized training for future jobs unrealistic. First, technological developments and change may take place with great rapidity. Entirely new ways of making a living have evolved in less than a generation. Second, technological developments are the results of applying scientific knowledge. Students who learn how and why as well as what, and those who discover relationships for themselves, develop patterns of action that lead to flexibility.

IV. Science in secondary education should help the student gain a sympathetic respect for the research scientist. First, ideas produced by the exceptional individuals in any area of our culture should be critically received by the layman. The citizen, and scientist as a citizen, is responsible for the uses made of the results of scientific investigation. Second, the student should recognize that many ideas are complex. An electron is but a tag on an idea.

These statements, it must be reiterated, are suggestive only. Scientists classify, measure, and seek relationships that are meaningful in the interpretation of observable phenomena. The secondary school student should achieve an increasing ability to do the same thing, but he need not classify or measure or seek relationships as the scientist does. He should learn to solve problems by solving his own problems, and he should become aware of the power and the responsibility of science for dynamic social action.

The role which the secondary school student will probably play has been suggested and a few science educators have presented their ideas concerning possible goals of education. What now? Are we to look at goals in retrospect and hope that they, by some means, will filter into the minds and behavior of students and teachers? As educators we must not forget that we have the responsibility of determining both goals and means.

STUDY GROUP F: *Science and the Education of Young Adults*

Reported by WILLIAM C. FORBES, *State Teachers College, Towson, Maryland.*

It was arbitrarily decided to limit discussion to consideration of young people in college. The group then focused its attention on the question: *Is the problem approach on the college level workable?* Several other questions became subordinate to this one. The principal ideas expressed are given in the following paragraphs.

The problem approach is a *method,* having certain sound bases in psychology and in our ideas of democracy. It enables us to help students find ways to relate a body of principles established in a field of knowledge. A student must structure his own thinking; this thinking is the only thinking useful to him. We aim at a synthesis of ideas useful or having value to the learner. Facts which are learned in a problem structure have greater transfer than those learned in isolation from any real problem.

An important aspect of the problem approach is an interpersonal situation in which ideas are exchanged freely. Day-by-day rapport may be reinforced by a conscious reduction of the social distance between students and teacher, occasional visits in homes of students, casual conversations on campus, pointed questions which come close to students' thinking, and by doing the *out-of-the-way* thing for class preparation. William Wilks, as part of a study of soil conservation at Troy, Alabama, capitalized on conversations with leaders in the community, conferences with teachers in public schools, interest questionnaires for students, and informal visits with his students.

One person described work with a class of 600 students. Useful were dinner meet-

ings, small-group discussions, and student assistants who worked with the small groups. The objective was involvement of students in the planning. Certain schools have used camp experiences to advantage, particularly during freshmen orientation week. Such experiences may teach us much about the development of rapport. Young people are far more willing to talk in such a situation than in a university office.

In the minds of teachers is a formidable list of limitations in the problem approach. However, for many of these one can suggest methods which simply enhance the problem approach. In a methods course in biology students may lack knowledge of actual problems about which they should be educated. Visitation in the schools provides a context for their identifying these problems. To assume that one approach is good for all students is fallacious, but the problem approach more than others is versatile in that it provides opportunity for contributions from all and individual development under group appraisal. In it are common objectives, not common subject matter. Students often refuse to plan together while the teacher is present; the teacher's role becomes one of a resource person whose absence at times may be of benefit to the learning situation. It may be that students' expressed problems require considerable foundation materials; laying this foundation may be the teacher's role. One person on a staff may find difficulty in operating on the problem approach unless the whole institution is committed to its virtues. Actual administrative blocks may exist. On the other hand, in one school the department chairmen are visiting classes in each other's departments, and then conferring on common objectives and problems.

Planning cooperatively consumes much time. One person spent six weeks of a two-semester course on initial planning with his students. He reported considerable learning during this period.

We work constantly in the face of the backgrounds and expectations of our students. We may thus be led to a course which is carefully planned and executed by the teacher. Even in this a teacher can take his students into confidence regarding the methods used, or rationale basic to his approach.

Certain problems may not be real to students, unless in a certain context: e.g., the *Negro* is no problem in certain communities; *he just is.* The Negro may, however, become a problem during an analysis of local housing.

Present evaluation techniques and comparative grading seem to be strong blocks against free interplay of ideas. Planning is often stymied, as long as a grade threat exists.

Low reading ability may become the central problem, potentially frustrating to the science teacher. Careful selection of materials to be read, emphasis on basic roots of terms, and remedial reading classes may be of help.

There exists the fear that the problem approach will *get out-of-hand.* Attacking a large problem demands that we take time out to teach a broad array of concepts. For example, water pollution leads to bacteriology, hence to biochemistry, to soil conservation, to politics. To some this is good: in the expanding area of material covered by the ramifications of the problem approach, far more is learned in total than in the conventional science course.

It may be easier to organize an *external body of knowledge* and deal with it directly. But the problem approach may be *far more fun.* The problem approach may not seem practical except in an experimental situation. On the other hand, perhaps teaching should be at all times *experimental*

Several illustrative problem areas were given: conservation of soil, housing, sewage disposal, fears of atomic energy in the

vicinity of atomic energy plants, alcoholic beverages, and setting up adequate eating places for students of a metropolitan university. The work of the class of Ruth Newman Dugan, New Jersey College for Women, was cited. It illustrates what can be done through cooperative planning, actual execution of a program, and continuation beyond the time limits of a course, in attacking the problem of *rat control* in a community.

A problem approach would reflect the community. Whether such work is for *general education* or for an aspect of training a specialized student, there are persistent problems facing both. Many are common to both.

The degree to which a teacher involves himself in the problem approach depends in great part upon three aspects of the situation: structure of the curriculum, experience of the students, and physical and administrative limitations of the school. All three must be considered when appraising the results from such an approach in an isolated science course.

In the field of science education there is considerable interest in the potentialities and limitations of the problem approach. It is recommended that there are real differences between a conventional science course and one aimed at problems of people in a community. However, it was the consensus that most teachers still prefer the conventional course.

STUDY GROUP G: *Science in Pre-Service Education*

Reported by George Pitluga, *Oswego State Teachers College, Oswego, New York.*

The group on pre-service education first addressed itself to the problem of the objectives of science education in the teacher training institutions. The group seemed to be in agreement that the objectives of general education were valid for the teacher training program even though they would be supplemented by the goals which were peculiar to the teaching profession. Since the graduates of such institutions are expected to implement the directives of general education in the elementary and secondary schools it seemed apparent that a curriculum organized with these goals in view was a logical necessity.

The group was aware that such brave sentiments are more easily expressed than realized. The achievement of the goals of general education imply an organization of science experience which may disregard the traditional academic barriers between chemistry, physics, and biology, for example. But can a person trained under the broad-fields approach succeed as a chemistry teacher in a traditionally organized curriculum? And if the student transfers to a liberal arts college, just how will such a generalized science course be evaluated? Such dilemmas were soluble, the committee believed, if we as a profession were willing to take the experimental approach in revising our science curricula, and were not over-anxious to solve the problem. The very animated reaction of the main body of the conference to this problem indicated that it is a critical one in the minds of those teaching science in the training colleges and schools of education.

The problem which received the major part of the consideration of the group was that of the relations of teaching methods proposed by the training colleges in relation to the changing situation in the elementary schools. It has been apparent for some time that the increased birthrate of the mid-forties will soon deluge our schools with a flood of children for which they will hardly be prepared. Large classes in rooms designed for groups of twenty to thirty children, shortages of materials, and laboratories are, generally speaking, not the teaching situation for which most of our modern methods have been designed. Should we revise our philosophy and our method to meet these new conditions, or should we bend our efforts toward preventing such an undesirable turn of events in our schools?

The consensus of opinion was that it would be more profitable to avoid treating the dilemma as an either-or problem. On the one hand it was felt that some modification of what is considered desirable methods could be made functional for large groups. For example, excursions could be made with large classes of elementary children if the assistance of parents was enlisted. In the upper elementary school and in the Junior and Senior High Schools a judicious use of committee work could provide opportunities for individual growth and expression on the part of the children.

At the same time it was felt that the teacher training institutions together with the rest of the profession, had an obligation to resist by all its means the threatened expansion of undesirable teaching and learning situations. It was proposed that some or all of the following steps might be taken to achieve this end:

(1) Work for reasonably small classes in the teacher training institutions.
(2) So use desirable methods of instruction that teachers-to-be will recognize and accept their value.
(3) In education classes particularly help students to become aware of the problems which they will face in the schools and urge them to avoid those communities which are unwilling to provide a reasonably adequate learning environment for their children.
(4) Have an alert and militant faculty and student body inform the public of the nature of the problem and to enlist the public's support in providing adequate facilities.
(5) Through membership in professional organizations urge those organizations to utilize all the means of communication to alert the public to its responsibility.

It was recognized that while this problem was not confined to the area of science teaching it was one upon which science teachers could ill afford to turn their backs.

SCIENCE EDUCATION AND THE DEVELOPMENT OF ABILITIES TO COPE WITH PROBLEMATIC LIFE SITUATIONS *

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A PROBLEM is a difficulty or inconsistency recognized by an individual. The inconsistency is perceived between the situation as it is and what we conceive to be a better state of affairs. "A problem arises when a living creature has a goal but does not know how this goal is to be reached." [1] There is an inconsistency between an individual's concept of "what is" and of "what should be." When sufficient tension arises as a result of this discrepancy, the individual will attempt to move toward a better state of affairs. A hungry boy, for example, recognizes that the situation in which he exists is not ideal. He realizes that there is a possibility of a better state of affairs. If the hungry boy stands before a bakery store window, the inconsistency between the situation as it is—he is hungry—and the situation as it might be—he could eat the bread and cake—is vividly portrayed. In this case, if the tension that arises as a result of this inconsistency is sufficiently great, the boy may very well break the bakery store window to get the bread and cake. This would be a direct method of solving a problem. He might cut his hand or be arrested, but he would get food. Our concern is to help individuals to know and choose the best possible course of action. If there were a

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[1] Karl Duncker, *On Problem Solving*, trans. Lynne S. Lees (Washington, D. C.: American Psychological Association, 1935), Vol. 58, No. 5, p. 1.

free source of food around the corner, breaking the window to get bread might be judged to be an inadequate response because better results would have been derived from other actions.

A problem involves the recognition of an inconsistency between a situation as it is and the concept of what would be a better situation. With this recognition may come an attempt to remove the inconsistency and therefore to improve the situation. A problem becomes a problem when it is recognized by an individual; until there is this recognition, there is no problem. Many of our so-called academic problems are, in this sense, artificial. A teacher cannot assign a student a problem; it is not a problem unless the student recognizes it as being vital to him. This does not preclude that a teacher should not recognize that certain situations are important. Nor, does it preclude teacher guidance and direction of student experiences. It may be judged desirable, for instance, that children should learn the essentials of an adequate diet. This does not mean that the teacher can say that students have problems concerning inadequate diets. However, it does mean that a teacher can, and should, bring the matter of diet to the attention of the students. After having done this, it becomes a problem for the students if they consider it of sufficient importance to warrant their further attention. When an individual is aware of only one possible diet, he does not have a freedom of choice. We cannot choose that which we do not know.

Although a problem is the concern of an individual, this does not necessarily mean that there cannot be group problems and group educational activities.[1] A problem becomes a group problem as individuals work together to cope with problems that they recognize individually. A farmer wishes to save the soil in order to be able to raise better crops. The fisherman, on the other hand, wants to conserve the soil in order to prevent the streams from becoming polluted. The individual problems are very different; the group has a problem in the sense that the group members can work on their individual problems together. In a sense, working in groups to cope with problems has several advantages. It can provide a broader collective base of experience from which suggestions or hypotheses can be drawn. A group, which includes a farmer, a fisherman and a soil conservation man, can probably suggest better hypotheses than could any single individual. Similarly, if all the people concerned are included in the group, there is a greater likelihood of successful action. Any attempt to deal with stream pollution due to soil run-off will have difficulty in enlisting the cooperation of the farmer if he is not included in the planning phase. Cooperative group action involves a cooperative determination of what the group action should be.

Problems are recognized in a context or situation. A problem is perceived in a situation along with other problems. One of the most crucial tasks is the investigation in the situation to determine the order or priority with which we should deal with problems. For instance, to take an absurd example, the conservation of humus may usually be considered important; it would be foolhardy, however, to be concerned with this if our house were on fire. In other words, the importance of a problem must be judged in terms of all other elements of a situation. Our actions in a problematic situation become rather superficial unless we are dealing with those elements or problems which are judged to be vital. Students who are forced to work on matters that they judge to be of little importance are not likely to unduly exert themselves in their educational endeavors.

How can the abilities to cope with problematic life situations be developed? We

[1] H. M. Evans, for instance, has suggested a "problem-centered group" as a needed and effective method of attacking problems. Hubert M. Evans, "The Social Character of Problem Solving," *Progressive Education*, April, 1949.

are anxious that students, not only develop the abilities to cope with their present problematic life situations, but we are also concerned that they derive something from their educational experiences which will be of value to them in future problematic life situations. Our educational problem involves the planning and directing of educational experiences in terms of the present and the future. When future problematic life situations are encountered, it should be possible to rely on prior educational experiences for guidance in coping with the problematic situations. From an educational situation we should be able to derive generalizations that we may predict will be valuable in future situations. It is quite likely that a lawyer who is called upon to defend an accused thief will be aided by a study of case histories of similar situations. He can draw upon his experiences in studying these case histories for suggestions for handling the defense of the accused thief. In this respect, he generalizes from his study of case histories and thus is better able to cope with the problem of defending the accused thief. In the same sense, it is our concern that students, when confronted with some of the more mundane problems of life, will have had experiences from which they can generalize.

In order to have generalization from one situation to another, there must be elements that are recognized to be common to both situations. The situation must be sufficiently similar to allow us to recognize elements of experience in one situation which may aid us in another. The lawyer was able to recognize elements in his study of case histories which would help him in defending the accused thief. Sufficient connections were recognized between the two situations to allow him to use the knowledge derived in the one situation to aid him in the new. Our task is to help students to have experiences to which they can relate the problems which confront them. They will have *learned* from these experiences as these relationships are perceived. The educational experiences should, therefore, have some common elements with the problematic situations in which, we may predict, the individuals may be involved.

The difficulty of predicting future experiences may, in certain cases, be exaggerated. There are certain "persistent life situations" which endure through both space and time. All individuals must secure sufficient food of the right kind. This adjustment must be made by everyone, and often a continued readjustment is required. The educational experience that would be the most similar to this adjustment would probably involve the actual study of this adjustment itself. In another instance, most individuals spend their lives in a single community or at least in a single culture. A community or a culture may be characterized by the necessity for meeting certain problems. By studying the community or culture we can determine what these pervasive problems are and, perhaps, develop a means for coping with them.

Other future problem situations are not as easy to predict. They may be unusual, and we cannot be certain that every person, or that every person in a particular community or culture, will recognize similar problems. However, problems are matters about which individuals are concerned; we can get an indication of what people are going to be concerned about from what they, at the present time, deem to be important. Matters assume importance because we predict that they will be of value in future situations. We can get some indication of what an individual's future experiences and future problems will be by what that individual considers to be vital in the present. This does not mean that our interests are inflexible or that we will not consider different matters to be important at different times. It does mean that the nature of our experiences is controlled by what we consider to be important, and that any future interests or judgments of value can come only as a result of our past experiences. A generalization is a prediction that some element of our educational

experience will be of value in a future situation. There is, therefore, a direct relationship between that which is considered to be important in the present and that which will be of concern in the future. There is this common element between the problems that are perceived now and those that will be recognized at some other time. Both the present problem and the predicted future problem have in common the element that they are recognized as important by the individual involved.

If we are to help an individual to develop the abilities to cope with problematic life situations, we should help the individual to have experiences to which future problem situations can be related. There must be some connection between these experiences and the future problem situation, and this connection must be perceived by the individual. It would seem, therefore, that in planning educational activities in an attempt to develop abilities to cope with problematic life situations we should center those activities around matters that are deemed to be important by the individuals involved. They should be centered around the problems that are recognized by individuals.

Again, this does not mean that our attention should necessarily be centered around every passing whim and fancy. It does mean that we should undertake an investigation to determine what problems do confront us, and which of them are of the greatest importance. Our educational activities should be centered around these important problems. Methods, techniques and subject matter, in turn, become important as they are perceived to be useful in our actions in a problem situation. We deal with and perhaps resolve some of the problem situations with which we are concerned. From our experience in working with these problem situations, we should develop abilities to cope with future problem situations. As we recognize or become aware of the relationships between the problems that confront an individual, we are deriving something from our experience which will help us to cope with other problems and resolve other problematic life situations.

BIBLIOGRAPHY WITH ANNOTATIONS FOR SCIENCE IN GENERAL EDUCATION AT THE COLLEGE LEVEL *

VADEN W. MILES

Physics Department, Wayne University, Detroit, Michigan

COMMITTEES, CONFERENCES, SYMPOSIA

1. American Association for the Advancement of Science, The Cooperative Committee on the Teaching of Science and Mathematics. "Recommendations of the Cooperative Committee," *American Journal of Physics,* XVI (April, 1948), 198.

The Committee will continue to study science in general education and science education of the specialist.

2. French, Sidney J. "The Place of Science in General Education: A Conference Report," *The Journal of General Education,* IV (October, 1949), 68–71. [Dean of the Faculty and Director of the Division of Natural Sciences, Colgate University.]

A summary of the Princeton Conference (1947) and the Harvard Conference (1949) on the place and function of science in general education. Some of the topics considered were: scientific method, use of historically important original papers, simple experimentation at home, laboratory experiments versus demonstrations, techniques gained from the natural sciences of use in other areas, and training teachers primarily for general education programs versus broadening the graduate studies without destroying specialization in a definite area or subject.

*A paper presented at the annual meeting of The National Association for Research in Science Teaching, Atlantic City, New Jersey, February 19, 1951. This bibliography of selected, recently published references, limited chiefly to the years 1945–50, inclusive, is intended as a guide for science teachers, deans, and other administrators who are developing programs of general education. An innovation in bibliography is the inclusion of the position of the author to help the reader form judgments and to aid him in selecting references to be read. Reprints are available from the author for fifty cents.

3. Lark-Horovitz, K. "The Cooperative Committee for the Teaching of Science: A Report to the AAAS Council, December, 1949," *Science*, CXI (February 24, 1950), 197–200.

The chairman of this influential committee of the American Association for the Advancement of Science recounts the work of the committee on problems of science in general education and presents an extensive bibliography of papers in which this work is reported.

4. McDonald, Ralph W. *Current Issues in Higher Education 1950.* Washington, D. C.: National Education Association, 1951. Pp. 3+253. [Executive Secretary of the Department of Higher Education of the National Education Association.]

This report of the fifth annual National Conference on Higher Education contains such chapters as: Instruction in General Education; Evaluation of Current Programs in General Education; and Objectives, Content, and Organization of General Education. Subsequent annual reports will probably contain valuable material on general education.

5. McDonald, Ralph W. *Current Trends in Higher Education 1949.* Washington, D. C.: National Education Association, 1949. Pp. 3+202.

This report of the fourth annual National Conference on Higher Education contains such chapters as: General Education—Philosophy and Patterns; Natural Science, Mathematics, Social Science, and the Humanities in General Education; Meeting Community Needs Through the Community College; and Appraising Student Achievement and Development.

6. McDonald, Ralph W. "Fundamental Issues in General Education," *The Journal of General Education,* IV (October, 1949), 32–39.

This paper, presented at the University of Wisconsin's Centennial Symposium on General Education, is recommended reading for all concerned with general education. After establishing the need for general education, the author discusses ten fundamental issues: clarifying objectives, content, organization, distribution, faculty, relating general education to specialized and professional programs; noninstructional activities; instructional procedure; diversification (adjustment of program to individual); and evaluation.

7. President's Scientific Research Board. *Manpower for Research.* Volume Four of "Science and Public Policy." A Report to the President by John R. Steelman, *Chairman.* Washington, D. C.: U. S. Government Printing Office, 1947. Pp. viii+166.

Appendix II, Section II, Science in Institutions of Higher Learning, pages 110–145, is of major importance in any attempt to consider the place of science for general education in relation to science in institutions of higher learning.

8. Report of the Harvard Committee. *General Education in a Free Society.* Cambridge: Harvard University Press, 1945. Pp. xix+267.

It is proposed that all students in Harvard College take either a one-year course in the principles of biological science or one in the principles of physical science. The latter is to be built around a core of physics with materials from chemistry, astronomy and geology introduced only to the degree that they are pertinent to the problems under discussion.

9. Rogers, Eric M. "The Good Name of Science: A Discussion of Science Courses for General Education in College," *Science,* CX (December 9, 1949), 599–604. [Associate Professor of Physics, Princeton University.]

The general student needs and deserves science courses that are an end in themselves—courses that give him an understanding of science. This article relates mainly the Princeton Conference (1947), in which the need for new science courses, their aims and their construction were discussed, and the Harvard Conference (1949) which held sessions concerned with the role of the historian of science, the relationship between the new science courses and studies in social sciences, and the training of teachers.

Diagrams and discussions are presented contrasting orthodox courses, "smorgasboard" (survey) courses, and Roger's well-known block-and-gap scheme for courses. The blocks, topics taught thoroughly, may be chosen from a single science or from several sciences. Across the gaps between blocks are discussion lines. The gaps reduce the content of the course so that there is time for discussion. Also discussed briefly are President Conant's case histories approach, the study of original documents, and courses in the history of science. [See references 64 and 75.]

STATUS AND TRENDS

10. Bullington, Robert Adrian. A Study of College Science Courses Designed for General Education. Unpublished Doctor's dissertation, Northwestern University, 1949. Pp. vii+311.

A summary of this report appears in *Science Education,* April, 1949, and March, 1951, and in the *Association of American Colleges Bulletin,* May, 1950. This study, sponsored by the American Association for the Advancement of Science, gives the most extensive statistical picture as of 1948–49 of the status, content, and trends in college science courses designed for general education. [See reference 152 for Washton's study of colleges of liberal arts.]

11. Bullington, Robert A. "Summary of a Study of College Science Courses Designed for General Education," *Association of American Colleges Bulletin,* XXXVI (May, 1950), 267–272. [Professor of Science, Northern Illinois State Teachers College, DeKalb.]

12. Bullington, Robert A. "A Study of Science for General Education at the College Level," *Science Education,* XXXIII (April, 1949), 235–241.

This article and its sequel in *Science Education,* March, 1951, provide the most comprehensive study readily available of science courses for general education. This article considers prevalence of courses, types of courses, changes in courses, science requirements, and trends.

13. Derbigny, Irving A. *General Education in the Negro College.* Palo Alto, California: Stanford University Press, 1947. Pp. ix+255. [Administrative Dean of Tuskegee Institute.]

In addition to studying the aims and patterns of general education programs in twenty Negro institutions, the author made a detailed analysis of the general-education offerings in three major divisional groups, including the sciences.

14. Isbell, E. R. "General Education in the Teachers' Colleges," *Educational Research Bulletin,* XXIX (January 18, 1950), 7–13, 27–28.

The general-education practices in 1948–49 of some twenty teachers colleges are summarized with regard to courses in world literature, history of civilization, physical science and biological science.

15. Lovinger, W. C. *General Education in Teachers Colleges.* Oneonta, New York: American Association of Colleges for Teacher Education, 1948. Pp. ix+119.

Data on the programs in the four-year curricula for elementary-school teachers in member-institutions of the American Association of Teachers Colleges were secured and analyzed.

16. Reynolds, Charles W. "Trends and Present Status of Generalized Science in State Teachers Colleges," *Science Education,* XXXIV (March, 1950), 77–80. [East Carolina Teachers College, Greenville, North Carolina.]

This is a report of the status and trends of science courses for general education as offered in 89 per cent of the four-year state teachers colleges in the United States in 1949. There are usually two separate required courses, one in the biological sciences and one in the physical sciences, involving lecture and individual laboratory work.

17. Van Deventer, W. C. "Trends and Problems in General Education College Science Courses," *Science Education,* XXXIII (April, 1949), 183–190. [For the Committee on Research in Junior-College Science, National Association for Research in Science Teaching, by W. C. Van Deventer, *chairman.*]

Scientists and administrators interested in developing programs of science for general education at the college level will find that this article and the research studies reported by Bullington and Washton [see references 10, 11, 12, 152] provide the best summaries available in the published literature of trends and problems in college science courses designed for general education.

18. Van Deventer, W. C. "Report of the Research Committee on Junior-College Science." *Science Education,* XXXII (April, 1948), 188–193. [Stephens College, Columbia, Missouri.]

A summary of replies to a questionnaire by 171 junior colleges and four-year institutions include types of courses being offered and methods being used. A bibliography of fifty references dealing with science for general education is provided.

METHODS OF SCIENCE

19. Barnard, J. Darrell, *et al.* "Problems Related to the Teaching of Problem-Solving That Need to be Investigated," *Science Education,* XXXIV (April, 1950), 180–184. [Professor of Science Education, New York University.]

This progress report of the Committee on Research in Secondary-School Science of the National Association for Research in Science Teaching deals with what is commonly called scientific method, problem solving, or the scientific method of inquiry. Since scientific method is often stated as an objective of science instruction for general education at all educational levels, this report has value for college teachers of science.

20. Bernal, J. D. "Science Teaching in General education," *Science Education,* XXIX (December, 1945), 233–240. [Birkbeck College, University of London.]

This article, which deals with the social functions of science, stresses that those who are not continuing in scientific careers should learn scientific method by practicing it.

21. Bingham, N. Eldred. "A Direct Approach to the Teaching of Scientific Method," *Science Education,* XXXIII (April, 1949), 241–249. [Associate Professor of Science Education, Northwestern University.]

The problems of almost forty experiments (general science, biology, physics, chemistry) suitable for teaching scientific method are given. Complete directions are given for the accumulation and treatment of data for one experiment.

22. Conant, James B. *On Understanding Science.* New Haven: Yale University Press, 1947. Pp. xv+145. [President, Harvard University.]

For the reform of the scientific education of the non-science major, President Conant proposed one or more courses on the Tactics and Strategy of Science. The objective would be to give a greater degree of understanding of science by the close study of a relatively few historical examples (case histories) of the development of science.

23. Conant, James Bryant. *The Growth of the Experimental Sciences: An Experiment in General Education.* Cambridge: Harvard University Press, 1949. Pp. iv+67.

A progress report on the use of the case method in teaching the principles of the tactics and strategy of science.

24. Conant, James Bryant (General Editor). *Harvard Case Histories in Experimental Science.* Cambridge: Harvard University Press, 1950.

Case 1. *Robert Boyle's Experiments in Pneumatics* by James Bryant Conant. Pp. ii+71.

Case 2. *The Overthrow of the Phlogiston Theory: The Chemical Revolution of 1775–1789* by James Bryant Conant. Pp. ii+59.

Case 3. *The Early Development of the Concepts of Temperature and Heat: The Rise and the Decline of the Caloric Theory* by Duane Roller. Pp. iv+106.

Case 4. *The Atomic-Molecular Theory* by Leonard K. Nash. Pp. v+115.

These case histories, often called the historical approach, are designed primarily for use by students who are non-science majors. The foreword presents some of President Conant's ideas with regard to the understanding of science, the use of the case histories, the methods of science, the advance of science and progress in the practical arts, and the pure and applied sciences.

25. Conant, James B. *Science and Common Sense.* New Haven: Yale University Press, 1951. 371 p.

Explains the methods of science through a historical approach.

26. Dewey, John. "Method in Science Teaching," *Science Education,* XXIX (April–May, 1945), 119–123. [Professor Emeritus of Philosophy, Columbia University.]

"Method in Science Teaching" was first published in 1916. The timeliness today of the article is emphasized by an introduction written by Dewey for this republication.

27. Diamond, Irving T. "A Note on the Role of Biological Science in a Liberal Education," *The Journal of General Education,* V (January, 1951), 158–164. [Instructor in the Natural Sciences in the College of the University of Chicago.]

The student at the level of general education uses materials which lead him to an understanding of the ways in which a biologist validates his conclusions. Reports of inquiry, involving laboratory and discussion, constitute the basis of the course. Examples of a problem in the field of genetics and of one dealing with diabetes are given.

28. Keeslar, Oreon. "A Survey of Research Studies Dealing with the Elements of Scientific Method as Objectives of Instruction in Science," *Science Education,* XXIX (October, 1945), 212–216.

29. Keeslar, Oreon. "The Elements of Scientific Method," *Science Education,* XXIX (December, 1945), 273–278. [University of Michigan.]

Each article by Keeslar contains one of the best lists of elements of scientific method available in the published literature. The list was validated by the expert opinions of twenty-two research scientists of the University of Michigan faculty.

30. Lampkin, Richard H. *Variability in Recognizing Scientific Inquiry.* Teachers College Contributions to Education, No. 955. New York: Bureau of Publications, Teachers College, Columbia University, 1949. Pp. ix+79. [Professor of Physical Science, State Teachers College, Montclair, New Jersey.]

"Elements of the Scientific Method of Inquiry" are listed on pages 70–72.

31. Lawson, Chester A. "Basic Biological Science at Michigan State College," *The Journal of General Education,* II (October, 1947), 75–82. [Head of the Department of Biological Science, Michigan State College.]

A committee set up the general and specific objectives of the biological science course in the Basic College. The pattern of the course is as follows: Kinds of Living Things; Characteristics Common to All Living Things; Maintenance of the Individual; Maintenance of the Species; Interrelationships; Biological Evolution. Materials introduced for each topic are given.

The laboratory program has four objectives: to teach the student the accepted procedure for making a scientific investigation; to give the student training in the use of the scientific method by asking him to use it in solving biological problems; to aid the student in transferring the training so received to everyday situations; and to aid the student in securing biological information through direct contact with biological material.

A long statement on scientific method addressed to the student is included. A "scientific method laboratory manual" and a series of examinations to measure the student's progress in using the scientific method are indicated.

32. Lewis, Ralph W. "How to Write Laboratory Studies Which Will Teach the Scientific Method." *Science Education,* XXXI (February, 1947), 14–17. [Associate Professor of Biology, Michigan State College.]

In writing laboratory studies, designed to teach the scientific method, for use in the department of biological science at Michigan State College, the author has developed the following set of eight rules:

1. List all the topics and facts which might be included.

2. Assume at the start that the orthodox treatment of the subject is not good and resolve to use as little of it as possible.

3. Write the laboratory study near a laboratory where each step can be tested as it is being written.

4. Take plenty of time so that original thoughts will have time to incubate.

5. Present facts as the results of experiments observed by students.

6. Have the student state a hypothesis or hypotheses based on the facts.

7. Have the student choose the best hypothesis and test it by the accumulation of other

facts, preferably those derived from experiments he himself has devised.

8. Have the student accept, restate, or reject the tested hypothesis.

33. Lewis, Ralph W. "An Analysis of a Laboratory Study Designed to Teach the Scientific Method," *Science Education,* XXXI (April, 1947), 157–164.

Complete laboratory directions are given for a study of photosynthesis, designed to teach the scientific method. This is a laboratory study taken from the *Guide for Laboratory Studies in Basic Biological Science* by the Department of Biological Science, Michigan State College.

34. Lombard, George E. F. "Self-Awareness and Scientific Method," *Science,* CXII (September 15, 1950), 289–293. [Graduate School of Business Administration, Harvard University.]

In a discussion of "What the Social Scientist Would Like His Students to Know About the Natural Sciences" at a Harvard University Conference on "The Place of Science in General Education," the author states that the two aspects of scientific method which he wishes students of human behavior could learn from the natural sciences are: (1) Skills of handling oneself in relation to one's data; (2) Skills of making relevent observations of nature.

35. Loud, Oliver S. "Designing Science Courses for General Education," *School Science and Mathematics,* L (April, 1950), 289–296. [Professor of Physical Science, Antioch College.]

As a result of a physical science work group which met at the University of Minnesota, Loud discusses several considerations dealing with scientific method, its transfer to non-science areas and evaluation of this transfer. Loud suggests four integrated courses for inclusion in a continuous, problem-solving core of the general education curriculum directed: (1) to personal-social needs; (2) to the one-world community; (3) to crucial contemporary issues; and (4) to processes whereby a community can be assisted to become a good one.

36. McGrath, Earl James. "Science in General Education," *The Scientific Monthly,* LXXI (August, 1950), 118–120. [U. S. Commissioner of Education.]

Insofar as general education in science is concerned, the emphasis should center around teaching the nature of scientific method in the type of general course which cuts across boundaries. Even science majors in college should be given more instruction dealing with the scientific method and the impact of science on modern life. Science educators also have the job of making science and its methods understandable to the lay citizen by participating in school forums and community adult education programs, and by offering their services to local newspapers and radio stations as interpretative writers and speakers.

37. Nagel, Ernest. "The Methods of Science: What Are They? Can They Be Taught?" *The Scientific Monthly,* LXX (January, 1950), 19–23. [Philosophy, Columbia University.]

An address given at a Harvard Conference on "The Place of Science in General Education." The author believes that there is but one scientific method which can be taught best in conjunction with concrete subject-matter materials of the sciences in courses organized to permit time for reflection on problems.

38. National Association for Research in Science Teaching, Committee on Research in Secondary-School Science. "Problem-Solving as an Objective of Science Teaching," *Science Education,* XXXIII (April, 1949), 192–195.

The Committee recognizes that ability to solve problems is not developed only at any one educational level. Discussed are: (1) the behaviors of individuals engaged in the process of problem-solving—behaviors concerned with identification of the problem, the establishment of facts about it, the formulation and testing of hypotheses, and the actions resulting from the testing; (2) the variation in sequence of activities in solving problems; (3) the abilities and attitudes basic to problem solving; (4) situations evoking problem solving; (5) problem solving in the classroom.

39. Owen, Gwilym E. "Some Contributions the Physics Laboratory Can Make to General Education." *American Journal of Physics,* XVII (May, 1949), 270–272. [Chairman of the Division of Physical Science, Antioch College.]

Three experiments (pendulum, measurement, heat) are so modified to help the student develop skill in using the scientific method under circumstances which are nearly enough similar to problems in his own life that he can transfer that skill to his own problems.

40. Wayne University, The Citizenship Education Study. *Problem Solving.* Detroit: Wayne University, 1948. Pp. 1–11. [Copies of the booklet are available from the University.]

The outline given for problem solving is:

I. Defining the problem
   - A. Encountering the problem
   - B. Selecting the problem
   - C. Wording the problem
   - D. Setting up tentative solutions

II. Working on the Problem
   - A. Recalling known information
   - B. Determining need for more information
   - C. Locating sources of information
   - D. Selecting and organizing information
   - E. Analyzing and interpreting information

III. Drawing a Conclusion
   - A. Stating possible conclusions
   - B. Determining the most reasonable and logical conclusions
   - C. Reaching a conclusion

IV. Carrying Out the Conclusion
   - A. Acting on the conclusion
   - B. Reconsidering the conclusion

After each subhead there are one or more questions listed under the topics Process, Cautions, Objectives. A study of this booklet provides supporting evidence that training in problem solving has broad applications in life and can be given in many ways other than in science courses.

CONTENT AND ORGANIZATION

41. Bell, Reginald. "A General-Education Program Based on Student Needs," *School and Society*, LXX (July 16, 1949), 39–40.

In 1948 San Francisco State College introduced a General Education Program based on student needs. The instructional plan is divided into four areas: individual development, home and family living, social and civic responsibilities, and vocational orientation. Lacks, needs, and evidences of maladjustments determine subject matter. The biology and health courses help the student understand life processes and problems of personal hygiene. Physical science surveys man's strides in conquering his environment and attempts to awaken the student to the impact of scientific progress upon modern technological society.

42. Bergman, George J. "A Determination of the Principles of Entomology of Significance in General Education," I. *Science Education*, XXXI (February, 1947), 23–32; II. *Science Education*, XXXI (April, 1947), 144–157. [Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.]

This research study presents fifty-two principles of entomology, each accompanied by the corresponding associated principle from Martin's extensive list of principles of biology of importance for general education. [See references 67, 68, and 69.]

43. Bingham, N. E. (Editor). "Introduction to Science," *Science Education*, XXXII (December, 1948), 299–366. [Associate Professor of Science Education, Northwestern University.]

A syllabus for the year 1947–48 of the Northwestern University Freshman Course in Science for Bachelor of Arts students. The course is given in two quarters following a quarter of introductory mathematics. There are two lectures and two discussion periods each week and a two-hour laboratory every other week. A topical outline is given for each of fifty-nine lectures on scientific method, biological science, and physical science (physics, astronomy, meteorology, chemistry, earth science). Complete directions are given for the laboratory experiments.

44. Blanchet, W. W. E. "Subject-Matter Topics Contained in Textbooks for Use in Survey Courses in the Natural Sciences, Part II," *Science Education*, XXXII (March, 1948), 88–93. [Professor of Science and Administrative Dean, Fort Valley State College, Fort Valley, Georgia.]

This article is a summary of a major research investigation to determine the subject-matter topics found in textbooks for use in survey courses in natural science. Ten textbooks were analyzed for topics in physical science; seven for biological science. Conclusion: There is a lack of agreement among authors of textbooks concerning the content of survey courses in the natural sciences. The composite topical outlines of physical science and of biological science are in: Blanchet, Waldo Emerson. A Basis for the Selection of Course Content for Survey Courses in the Natural Sciences. Unpublished Doctor's dissertation, University of Michigan, 1946. Pp. vii+339.

45. Blanchet, W. W. E. "Investigation of Student Opinion Concerning Survey Courses in Science," *Science Education*, XXXII (February, 1948), 24–32.

The purpose of this investigation was to determine the opinions of students concerning the relative values of topics which they had studied in survey courses in the natural sciences. A table shows the rank of each topic relative to the complete list of 276 topics; the rank of each biological topic relative to the 42 topics which were contained in the list of biological topics; and the rank of each physical topic relative to the list of 234 such topics. Lack of agreement by the students with respect to which topics were valuable for inclusion in survey courses in science would seem to indicate that such opinions are of little value in selecting course content.

46. Blisard, Thomas J. "Developing Physical Science Experiences Through the Use of Co-operative Group Processes," *Science Education*, XXXIII (December, 1949), 366–371. [Newark College of Engineering.]

At Madison College (Virginia) the physical science survey course was replaced by a co-operative group investigation in which physical science experiences were had in the study of housing.

47. Bullington, Robert Adrian. "A Study of Student Opinion of College General Education Science Courses," *Science Education*, XXXIV (March, 1950), 73–77. [Professor of Science, MacMurray College, Jacksonville, Illinois.]

A summary of student opinion of two courses is categorized as follows: length of course, teacher system, demonstrations, audio-visual aids, laboratory, quiz-discussion period, subject-matter content, general opinion.

48. Charters, W. W. "Patterns of Courses in General Education," *The Journal of General Education*, I (October, 1946), 58–63. [Director of Research Service, Stephens College.]

Two major patterns of curricula in general education can be identified in American Colleges: subject-matter patterns and needs patterns. The needs pattern as developed in the curriculum of Stephens College was processed by the collection and classification of the activities of American women. Seven areas selected as basically important to all women are: communications, psychology, health, consumer problems, social problems, humanities, and philosophy of living.

49. Clark, C. C. "College Physical Science Courses in General Education," *American Journal of Physics*, XVII (May, 1949), 267–269. [Professor of Physical Science and Chairman of

General Course Group, School of Commerce, New York University.]

Discussed are: the objectives of a physical science course for the general education of the non-science major, the basic principles to be followed in determining the content of the course, the inclusion of historical examples of the development of science, and the methods which should be used in teaching such a course. Administrators and teachers will profit from reading this analysis based on the experience of the author who has taught such a course for fifteen years.

50. Conant, James B. "Some Aspects of Modern Harvard," *The Journal of General Education*, IV (April, 1950), 175–183. [President, Harvard University.]

Each student must elect three elementary courses in General Education early in his college program: one of four parallel courses in the Humanities, the same in the Social Sciences, and one in the Natural Sciences. The latter is elected from four parallel courses in the Physical Sciences and one in the Biological Sciences. Three advanced courses in General Education must be elected. One in science, for example, is "The Impact of Science on Modern Life."

51. Curtis, Francis D., *et al.* "Symposium: How Can Science Education Make Its Greatest Contribution in the Post-War Period?" *Science Education*, XXVIII (October, 1944), 231–238. [Professor of the Teaching of Science, University of Michigan.]

Curtis pointed out that science education must effect post-war revision of high school and college survey science in order to strengthen beyond its pre-war force the ideal of science for general education. The three major objectives of post-war science would be to stress the teaching of scientific principles, to emphasize the development of scientific attitudes, and to define and direct the training in the skills of problem solving.

52. Delo, David M. "Role of the Earth Sciences in General Education," *Science*, CXII (July 14, 1950), 59–60. [Executive Director of the American Geological Institute.]

Delo contends a firmer basis for better living and more understanding of citizenship would result if colleges discarded traditionalism and approached science for general education by attacking national problems such as use of land, the water problem, the soil problem, and mineral resources. He states that the sciences which deal with the physical environment rest on application of the fundamental laws of other sciences. He disagrees with Eric Rogers' discussion of science courses for general education (See reference 9).

53. Federighi, Henry, and Clarence Leuba. "The Proper Study of Mankind is Man: A Two-Year Course on Man and His Relation to the Living World," *The Journal of General Education*, II (April, 1948), 193–198. [Professor of Biology and Professor of Psychology, Antioch College.]

The two-year Life Science course at Antioch College, with emphasis on an understanding of man and of other forms of life important to his welfare, is considered from the standpoint of objectives, content, conduct, and student appraisal of the course. The outline of the course shows a two-year sequence which integrates contributions from anthropology, biology, psychology, and sociology. The authors are preparing such a textbook. An integral part of the course are the services available to the students from the departments of biology, psychology, education, personnel, health and physical education, and speech.

54. French, Sidney J. "Science in General Education," *The Journal of General Education*, I (April, 1947), 200–205. [Dean of the Faculty and Professor of Chemistry, Colgate University.]

The first semester of the course Problems of Natural Science is devoted to ten problems in physical science, and the second semester to seven problems of biological science. These seventeen problems are listed. Examples of problems are: What is combustion?; How is the earth's food supply continually renewed? The author stresses that if such a course is of value to the nonscientist because it stresses methods by which scientists have attacked and solved problems, it should be even more valuable to prospective scientists who get very little of either the philosophy of method or the social significance of science in their technical training.

55. French, Will, *et al.* "The Imperative Needs of Youth," *Bulletin of the National Association of Secondary-School Principals*, XXXI (March, 1947), 1–144. [Professor of Education, Columbia University.]

The imperative needs of youth with respect to science as discussed by J. Paul Leonard should be considered in the planning of college programs of science for general education. San Francisco State College of which Dr. Leonard is president is now (1950–51) developing a general education program which considers the needs of youth. [See reference 132.]

56. Friedenberg, Edgar Zodiag. *A Technique for Developing Courses in Physical Science Adapted to the Needs of Students at the Junior College Level.* Doctor's dissertation, University of Chicago, 1946. Pp. vi+253. [Available from the author, Instructor and Examiner in Physical Science, University of Chicago.]

A description of the "needs approach," the method of developing a course in chemistry adapted to the needs of students at Oklahoma A. and M. College, and an appraisal of success in meeting the needs of students are included. [See reference 92.]

57. Fuller, Edward C. "The Bard Plan of Teaching Science," *The Journal of Higher Education*, XXI (February, 1950), 72–76. [President of Bard College.]

The Bard Plan approaches the basic sciences (biological and physical) as a unified field of study of knowledge and methodology for all freshmen and science majors. Features of the plan are: (1) a sophomore review of interest, potentialities, and future plans; (2) a winter field period of eight weeks for each of four years for work in laboratories; and (3) for the science major a senior project and a junior-senior-faculty colloquium in which the history, philosophy and methodology of science are studied.

58. Garrett, Alfred B. "Science and the Liberal Arts," *The Journal of General Education,* III (April, 1949), 216–220. [Professor of Chemistry, The Ohio State University.]

The nature of a required course in science in the liberal-arts college is discussed in terms of objectives, content, instruction, and problems that the introduction of such a course will raise. A two-year science program, one year of physical science followed by one year of biological science, is suggested.

59. Goran, Morris. "The Physical Science Survey Course in General Education," *Science Education,* XXXIV (March, 1950), 94–96. [Chairman of the Department of Physical Science, Roosevelt College, Chicago.]

This experienced teacher of physical science gives threads which can be used to correlate the physical sciences and makes a number of practical suggestions for the effective teaching of such a course.

60. Hall, Thomas S. "Implications of General Education for the Teaching of Biology," *The Journal of General Education,* II (January, 1948), 107–116. [Department of Zoology, Washington University, St. Louis.]

On the assumption that biology will continue to exist as a separate course in programs of general education, the author (1) discusses six possible organizations of the biology course; (2) describes an experiment at Washington University in which the student is first introduced to each of six problems (year's work) in the laboratory followed by readings, discussions, and finally lectures showing the connection of each of the problems to the science of biology; (3) presents as used in the course a listing of original classical papers each of which constituted the opening of a new major area of biological investigation and thought; (4) presents a laboratory exercise in which the students examine the stained chromatin cells from an onion tip and discover the process of mitosis for themselves. The student is led to make generalizations of his own, rather than to corroborate the great generalizations of classical biology memorized in advance.

61. Henderson, Algo D., and Dorothy Hall. *Antioch College: Its Design for Liberal Education.* New York: Harper and Brothers Publishers, 1946. Pp. xiv+280. [Professor of Higher Education, University of Michigan.]

This college, noted for its work-study plan, has one kind of required courses directed toward underlying concepts of our civilization. All students take chemistry, physics, life science (biology and psychology), geology, and astronomy.

62. Henshaw, Clement L. "Do Students Find History Interesting in Physical Science Courses?" *American Journal of Physics,* XVIII (September, 1950), 373–377. [Associate Professor of Physics and Director of the Core Course in Natural Science (physical), Colgate University.]

The answer: yes, for some problems (e.g., astronomy); no, for others (e.g., caloric theory). Students agreed (3 to 1) that they liked to get into the history of a scientific problem, because they then understood the problem better. However, the history was introduced after the students had wrestled with the problem for several days. A partial description is given of the Colgate course during its fourth year.

63. Kemble, Edwin C. "A General Education Course in Physical Science for Superior Students," *The Journal of General Education,* II (July, 1948), 322–327. [Professor of Physics, Harvard University.]

Students were placed in three different groups for instruction: (1) those with aptitude for mathematics and physics; (2) those interested in the practical applications of science; (3) those interested in the history of science. For those in the first group, the chief task of the first semester was to recount the story of the development of the astronomy of the solar system and the formulation of the basic laws of mechanics by Galileo and Newton, of the second semester, the story of the development of the ideas involved in our present understanding of matter and radiation. In addition to three regular lectures, one two-hour period was available each week for conferences, oral discussions, and laboratory work. Group demonstrations appeared to be replacing laboratory work.

64. McGrath, Earl J. (Editor). *Science in General Education.* Dubuque, Iowa: Wm. C. Brown Company, 1948. Pp. viii+400. [Dean of the College of Liberal Arts, The State University of Iowa.]

Science courses in general education and trends in such courses are discussed. Reasonably complete descriptions of representative science courses for general education, as found in twenty-one colleges and universities, are given. The institutions are: universities—Boston, Colgate, Chicago, Harvard, Princeton, Wisconsin, Iowa, Florida, Northwestern, Kansas City, Wesleyan, Louisville; four-year-colleges—Haverford, Oberlin, Oklahoma Agricultural and Mechanical, Antioch, Kansas State Teachers, Colorado State College of Education, Western Washington College of Education, Pennsylvania State College for Women; two-year institution—Stephens College.

65. McGrath, Earl J. "The Future of Science in Liberal Education," *American Journal of Physics,* XVI (September, 1948), 348–352.

For the layman, McGrath recommends a course in physical science including subject matter from the fields of chemistry, physics, geology, astronomy and mathematics, and one in biological science including subject matter from botany, zoology, human anatomy, physiology, and bio-chemistry. He suggests intensive treatment of selected topics in a way that students will understand the methods of science. He believes that the policy of placing a premium upon research at the expense of scientific instruction for undergraduate students will have a disastrous effect upon American society.

66. McGrath, Earl J., *et al. Toward General Education.* New York: The Macmillan Company, 1948. Pp. ix+224. [Members of the faculty of the University of Iowa and of Wayne University.]

The authors do not believe that the objectives of science in general education are best met by survey courses. They suggest that the student be required to take a one-year course in the biological sciences and either of two one-year courses in the physical sciences. One of the latter courses is to cover chemistry and geology; the other mathematics, astronomy and physics. Demonstration experiments are recommended in lieu of required laboratory work. However, the laboratory would be available for the use of students. Many suggestions are made for subject matter to be included in the three courses. Those topics which contribute most toward the general education and general living of the student are to be emphasized.

67. Martin, W. Edgar. "A Determination of the Principles of the Biological Sciences of Importance for General Education," *Science Education,* XXIX (March, 1945), 100–105. [University of Michigan.]

68. Martin, W. Edgar. "A Determination of the Principles of the Biological Sciences of Importance for General Education. II." *Science Education,* XXIX (April–May, 1945), 152–163.

One hundred major principles which were found to rank highest in importance for purposes of general education are listed in order of their decreasing value. The complete list of 300 "Major Principles of the Biological Sciences of Importance for General Education" is now available from Dr. W. Edgar Martin, Office of Education, Federal Security Agency, Washington 25, D. C. [See reference 69.]

69. Martin, W. Edgar. "The Major Principles of the Biological Sciences of Importance for General Education," Circular No. 308. Washington: Office of Education, 1948. Pp. 30. Free. [Assistant Specialist for the Biological Sciences, U. S. Office of Education.]

Three hundred principles are arranged under one or more of twelve topic headings: e.g., genetics and heredity. The statements of the principles and their relative importance for general education (also indicated) were determined by defensible research techniques.

70. Martin, W. Edgar. "A Chronological Survey of Research Studies on Principles as Objectives of Instruction in Science," *Science Education,* XXIX (February, 1945), 45–52.

Definite trends are revealed which are of importance for the organization and presentation of the materials and learning experiences of science instruction for purposes of general education.

71. Martin, W. Edgar. "A Chronological Survey of Published Research Studies Relating to Biological Materials in Newspapers and Magazines." *School Science and Mathematics,* XLV (June, 1945), 543–550.

On the basis of frequency of occurrence in magazines and newspapers, the biological content of a program of general education should include these important topics: human biology; health and disease; animal biology; foods and nutrition; and plant biology.

72. National Society for the Study of Education, Forty-Sixth Yearbook, Part I. *Science Education in American Schools.* Chicago: The University of Chicago Press, 1947. Pp. xii+300.

The Yearbook Committee says, "In one or both of the junior-college years, survey courses in both the physical and biological sciences should be offered for general education along with pretechnical courses planned for those who will need specialized training in science."

73. Nedelsky, Leo. "Formulation of Objectives of Teaching in the Physical Sciences," *American Journal of Physics,* XVII (September, 1949), 345–354. [Associate Professor of Physical Sciences and Examiner, University of Chicago.]

Discussed are: (1) the objectives to be achieved—explicit statement of methods of arriving at and form of behavior objectives; (2) possible behavior objectives—knowledge, ability to use the methods of science, ability to read scientific literature, proper attitudes and habits; (3) criteria used in making up the list of behavior objectives—communicability, importance, teachability, testability, comprehensiveness. Nedelsky maintains that the objectives of a course should be stated explicitly and in considerable detail; that teaching should be directed consciously and specifically toward the achievement of these objectives; and that the degree of achievement of the objectives should be measured.

74. Pugsley, Albert L. "Reaching the Toddling Age." *The Journal of General Education,* II (July, 1948), 341–345. [Dean of Administration, Kansas State College of Agriculture and Applied Science.]

A brief description of two comprehensive courses—Man's Physical World and Biology in Relation to Man—first introduced at Kansas State College in 1944.

75. Rogers, Eric M. "The 'Block and Gap' Scheme for Physics Courses," *American Journal of Physics,* XVII (December, 1949), 532–541. [Associate Professor of Physics, Princeton University.]

This is "a must" on any reading list. The phrase "Physical Science Courses for General Education" should replace "Physics Courses" in the title. Diagrams accompany this detailed discussion of the now well-known "block-and-gap scheme" [so well known that many call it the block-and-tackle approach]. Rogers proposes that the blocks be treated thoroughly as to subject matter, and that the blocks extending outward across gaps to other topics and sciences in other blocks be clearly related. Connecting these blocks are lines across the gaps along which flow interrelationships. The gaps are essential to reduce the content of the course so that there is time for discussion, time for ideas to sink in, and time for the student to look back and reconsider. [See references 9 and 64.]

Rogers believes that in such a course it is important to develop only a few basic principles and their implications, to teach scientific method(s), to give creative work, and to show by means of picked specimens carefully treated, what science is like, how scientific work is done, and what scientists are like as thinkers and workers. Cogent analyses are made of the need for new science courses, the case for and against orthodox courses, and the problem of transfer of training. (If ease and amount of transfer increase with increasing general intelligence, then the brightest students should profit most from courses for general education.)

76. Rush, R. I. "Determining and Implementing Objectives for a General Course in the Physical Sciences," *The Journal of General Education,* II (January, 1948), 138–143. [Professor of Chemistry, Centre College of Kentucky.]

In formulating objectives of the general course in physical science, the author (1) tested each objective in terms of practical criteria; (2) attempted to determine the needs of the students; (3) made a study of the resources (intellectual skills, personality traits, understandings) students could gain as a result of the study of physical science. He then determined which of these would help to meet some of the student needs. An example is given of one problem, activities to engage in to solve the problem, and resources needed.

77. Sayvetz, Aaron. "The Natural Science Program in the College of the University of Chicago," *The Journal of General Education,* I (January, 1947), 131–135. [Assistant Professor of the Physical Sciences, University of Chicago.]

A one-year course in general mathematics, offered in the equivalent of grade eleven, is followed by a three-year course in the natural sciences. The first year of natural science consists of physics and chemistry offered in the equivalent of grade twelve; the second year of physiology, genetics and evolution; and the third year of the atomic structure synthesis of physics and chemistry in the first half and psychology in the final half. Nearly all of the printed matter offered to the students consists of original or review papers written by scientists for an audience of scientists. Fifty such titles are listed for the first two years. A class has three one-hour discussion meetings (not lectures) and one two-hour laboratory period each week. [See reference 80.]

78. Schwab, Joseph J. "The Nature of Scientific Knowledge as Related to Liberal Education," *The Journal of General Education,* III (July, 1949), 245–266. [Professor of Natural Sciences in the College and Chairman of the College Natural Science Staff, University of Chicago.]

An erudite, philosophical discussion for which the educational implications are that liberal programs in science contain original records of scientific research. It is implied that newer members of the faculty of a liberal program can learn disciplines beyond the ones learned in their profession only by participation in courses which require and evoke them and which are manned by teachers which already have them; in brief, an apprenticeship is implied.

79. Stickler, W. Hugh. "Progress Report on a Year's Work in General Education at Florida State University," *The Journal of General Education,* III (April, 1949), 221–224. [Chairman of General Education, Florida State University.]

A description of the experiences of the faculty in its attempt to improve its program of general education; the administrative organization devised to direct the program; and the difficult problems of chief concern. Valuable ideas are available for the guidance of those who are developing similar programs.

80. *The Idea and Practice of General Education* by present and former members of the faculty of the College of the University of Chicago. Chicago: The University of Chicago Press, 1950. Pp. xi+333.

This account of the College of the University of Chicago in its second decade considers the problem of general education and its history; the curriculum (humanities, social sciences, natural sciences, mathematics, writing, languages, integration); and method (teaching, examining, advising). The unique program of the physical sciences is discussed by Joseph J. Schwab, chairman of the College Natural Sciences Staff; that of the biological sciences by Merle C. Coulter, professor of botany and Associate Dean of the Division of Biological Sciences. Comprehensive reading lists used in the physical and biological sciences are included. Many will profit from the experiences of the College with a problem laboratory.

81. Todd, Robert E. "Biology in a Program of General Education," *The Journal of Higher Education,* XX (February, 1949), 71–76, 113. [Associate Professor of Zoology and Director of the Core Course in Natural Science (biological), Colgate University.]

A description of the semester course in biological science for freshmen at Colgate University. The criteria employed in selecting the problems around which the work is organized are discussed.

82. Van Deventer, W. C. "Organization of a Basic Science Course," *Science Education*, XXX (October, 1946), 201–206. [Professor of Biology, Stephens College.]

The general biology course at Stephens College was oriented, because of a research study, toward present and future needs of students. Eight subject-matter areas were allocated to three subdivisions of human ecology: Man in relation to the living world, to the things that he uses, and to the ideas that shape his actions. Student problems furnished a means of analysis by which the eight areas could be used in teaching. A program of instruction, consisting of projects and group experiences chosen on the basis of individual interests and needs, was organized.

83. Van Deventer, W. C. "Individualized Instruction in a Basic Science Course," *Science Education*, XXX (December, 1946), 269–273.

The methods of operating the general biology course at Stephens College with maximum use of individualized methods are presented. The methods have resulted from eight years of experimentation. Experimentation with individualized techniques, administration of an individualized course, and evaluation of student achievement are described.

84. Washton, Nathan S. "What Science Course for General Education?" *Association of American Colleges Bulletin*, XXXV (December, 1949), 509–518. [Chairman, General Science, Rutgers University.]

This article suggests procedures for determining the objectives of general education, selecting major principles of science, applying scientific principles, constructing a syllabus, and evaluating courses. Many questions are discussed to show the relation of science to education, changes in society, communication, public welfare, atomic energy, health, and the concept of one-world.

85. Wise, Harold E. "The Major Principles of Physics, Chemistry, and Geology of Importance for General Education." Washington: Office of Education, 1948. Pp. 18. Free. [Assistant Dean of the Graduate School, University of Nebraska.]

Two hundred seventy principles are arranged under major topics common to the fields of physics, chemistry and geology. The statements of the principles and their relative importance for general education (also indicated) were determined by defensible research techniques. The research study in which this list was developed was completed at the University of Michigan and was reported by Wise in *Science Education*, Volume 25 (December, 1941), Volume 26 (January, 1942), and Volume 27 (February, September, October, 1943).

86. Wise, Harold E. "A Review of Recent Research Reports in Science Education with Implications for Teaching at the Junior College Level," *Journal of Educational Research*, XLIII (January, 1950), 343–356.

An excellent summary of published research relating to the teaching of science at the junior-college level during the last decade is provided in this study. The research reports may be assigned to three general classifications: studies relating to either the objectives or organization of general education science courses; methods studies involving the use of control and experimental groups; and studies which emphasize the identification of specific abilities related to science instruction.

EVALUATION

87. Brewer, W. Lyle. "Factors Affecting Student Achievement and Change in a Physical Science Survey Course," *Science Education* (February, 1943), 28–31. [Physicist, Eastman Kodak Company.]

It was found that measures taken at the beginning of the survey course could be used to predict with a high degree of accuracy the final grade marks of the students at the end of the course; that students could demonstrate some ability to apply science information in solving new problem situations; and that failing students who later repeat the survey course gain very little from a second exposure.

88. Downie, N. M., and C. R. Pace. "A Study of General Education at Syracuse University with Special Attention to Objectives," *Educational and Psychological Measurement*, X, Part I (Autumn, 1950), 359–366. [State College of Washington and Syracuse University.]

An all-university self-survey showed that students and faculty considered the attainment of objectives of general education as important goals and that students felt that they were making "some" but "not much" progress toward the achievement of the goals. There was a significant difference between the importance placed on various objectives by faculty and students.

89. Dressel, Paul L. "Evaluation Procedures for General Education Objectives," *The Educational Record*, XXXI (April, 1950), 97–122. [Director of the Cooperative Study of Evaluation in General Education and Chairman of the Board of Examiners at Michigan State College.]

Nineteen questions aimed at evaluation of the growth of the individual are discussed. An adequate evaluation of a course or program must be based primarily on evaluation of changes brought about in individuals by their experiences in the course or program.

90. Dunning, Gordon M. "The Construction and Validation of a Test to Measure Certain Aspects of Scientific Thinking in the Area of First Year College Physics," *Science Education*, XXXIII (April, 1949), 221–235. [Professor of Science, State Teachers College, Indiana, Pennsylvania.]

A valid paper and pencil test was constructed in objective form to evaluate certain aspects of scientific thinking (interpretation of data and ability to apply principles) in the area of first-year college physics. Such tests can be used in courses of physical science for general education.

91. Dunning, Gordon M. "Evaluation in Science," *The Science Teachers Bulletin* (of the New York State Science Teachers Association), XII (April, 1947), 5–7, 34–39.

Abilities ascribed to scientific thinking are listed. Examples of tests are shown for reading and interpreting data, knowledge and applications of principles, and abilities associated with the nature of proof.

92. Friedenberg, E. Z., and Otto M. Smith. "Adapting a College Chemistry Course to Student Needs," *Journal of Chemical Education*, XXV (December, 1948), 681–685. [Instructor and Examiner in Physical Science, University of Chicago; Head of the Departments of Chemistry and Chemical Engineering, Oklahoma A. and M. College.]

A chemistry course in which an experimental procedure was used was compared with a course using traditional procedure with respect to seven areas of need of students. The experimental group was found to be superior only in the ability to use chemistry to be an effective consumer of goods, to support intelligently necessary public services, and to earn a living by a worthwhile contribution to the community (in this case, agriculture). [See reference 56.]

93. Geer, Willard. "Objectives Students Seek in Physics Survey Courses," *Science Education*, XXXIII (March, 1949), 152–155. [Physics Department, University of Southern California.]

In answer to an opinionnaire, students have a serious desire to know about the laws and principles of science and how they are applied. There was little concern with the historical background of science, but much concern with personal adjustment in the newly forming world of science. Skills in laboratory practice and problem solving were rated low among the objectives of non-science majors.

94. Pace, C. Robert. "Evaluating the Outcomes of General Education," *The Journal of General Education*, I (January, 1947), 125–130. [Head, Field Research Section, Bureau of Naval Personnel.]

Evaluation is conceived to encompass five tasks: to formulate objectives; to define general objectives in terms of student behavior; to identify the sources of evidence which can be used in observing this behavior; to develop methods for getting this evidence; and to summarize, integrate and interpret the evidence in relation to the specific objectives. Several instruments of potential use in evaluating the outcomes of general education were suggested. It was suggested that an evaluation program is not complete until evidence has been collected from former students and graduates of the college, as was done by the University of Minnesota and published in the book *They Went to College*.

95. Solomon, Marvin D. and G. Edward Braunschneider. "Relation of Biological Science to the Social Attitudes," *Science Education*, XXXIV (March, 1950), 80–84. [Department of Biological Science and Department of Anatomy, Michigan State College.]

The data from a study using control and experimental groups indicate that the teaching of the biology of the races of man with the intent of applying the scientific method of thought to the problem of racial, religious and natural prejudice does have a beneficial effect.

96. Van Der Jagt, Ervin R. "A Study of the Performance of Basic Biological Science Students in Advanced Biology Courses," *Science Education*, XXXIV (March, 1950), 85–93. [Associate Professor of Biological Science, Basic College, Michigan State College.]

This research study shows that students who have had Basic Biological Science, a course designed for general education, do not appreciably improve their performance in advanced courses in botany and zoology by electing additional preparatory courses, and do as well in such advanced courses as students who have had specific preparation for them. The study also shows that students who accelerate at the end of two terms, from Basic Biological Science to advanced courses via the Basic Biological Science comprehensive examination, do better in advanced courses than do those students who take all three terms of Basic Biological Science.

97. Wantland, Wayne W. "The Role of Science in General Education and Some Suggestive Methods of Evaluation," *Association of American Colleges Bulletin*, XXXVI (May, 1950), 257–266. [Chairman, Division of Science, Illinois Wesleyan University.]

Most of nine items listed, which science hopes to achieve in students, are recognized as scientific attitudes and elements of scientific method. With regard to evaluation, suggestions are made as to how to check abilities, activities and changes in students; and to interpretation of data, application of principles, and courses of action in solving problem situations.

98. Weaver, Edward K. "Evaluation of Student Achievement in Science," *Science Education*, XXXII (March, 1948), 81–87. [Professor of Science, Bishop College, Marshall, Texas.]

Listed are: techniques for collecting evidence of student development, items under which changes in behavior may be classified for analysis, and objectives. Specific examples are given of the use of these listings in the State Teachers College at Montgomery, Alabama. The method of determination of grades is discussed.

99. Woodburn, John. "Constructing Machine Scorable Examinations in the Natural Sciences," *The Science Teacher*, XVII (December, 1950),

213–217. [Assistant Professor of Science, Illinois State Normal University, Normal, Illinois]

Examples are given for the testing of sixteen different types of abilities by means of questions constructed for machine scorable examinations.

HISTORY OF SCIENCE*

100. Cohen, I. Bernard. "A Sense of History in Science," *American Journal of Physics*, XVIII (September, 1950), 343–359. [Assistant Professor of the History of Science and of Physical Science, Harvard University.]

Those who wish to include some of the historical approach in their science courses for general education will find herein carefully selected reading references from which a grounding in the history of science may be acquired.

101. Steinhart, Victor. "Errors in the History of Science," *American Journal of Physics*, XVIII (September, 1950), 399–400. [Cornell University.]

The author is currently working on a carefully annotated bibliography of the history of physics. He suggests that until a good guide to the sources exists, the history of physics might better be kept out of textbooks unless materials are checked by a competent historian of science.

102. Strong, E. W. "Why Teach History of Science?" *The Journal of General Education*, IV (July, 1950), 250–255. [Professor of Philosophy and Chairman of the Department of Sociology and Social Institutions in the University of California at Berkeley.]

The cogent reasons given for the teaching of history of science should be considered in view of President Conant's proposal to include history of science as instruction which a student may receive in partial satisfaction of undergraduate requirements in natural science.

JUNIOR COLLEGE

103. Engelhart, Max D. "Examinations to Facilitate Transfer of Junior College Graduates to Senior Colleges," *Junior College Journal*, XX (February, 1950), 332–336. [Chicago City Junior College.]

Intermediate tests for college students are of two types: the College Ability Test and the Proficiency Tests. Information on these tests, first given in 1950, may be secured from the Educational Testing Service, P.O. Box 592, Princeton, New Jersey, or P.O. Box 2416, Terminal Annex, Los Angeles, California. Both junior colleges and the undergraduate division of senior colleges will find this national program of value in recommending admissions to senior colleges.

104. Frazier, Alexander. "General Education in the Junior College: Lessons from the High School," *The School Review*, LVIII (April, 1950), 201–210. [Phoenix (Arizona) Union High School and Phoenix College.]

Some of the lessons that the junior college has to learn from the high school in providing a tenable program of general education are: (1) sound curriculum development is built upon a knowledge of life-needs of learners; (2) sound organization of learning experiences is based upon a topical or problem approach rather than a chronological approach; (3) sound development in the general education curriculum is based on the use of multiple-learning materials and experiences; and (4) sound general education is based on a concern for, and evaluation of, individual growth.

105. Hall, Luella J. "What is the General College?" *California Journal of Secondary Education*, XXV (October, 1950), 347–351. [Dean of the General College, Hartnell Junior College, Salinas, California; member of the California State Committee sponsoring the Study of General Education in the Junior College.]

Hall considers the junior college with reference to meeting the educational needs of the community: (1) preparation for advanced work in a university; (2) general education for those not planning to attend a university; (3) specialized preparation for particular occupations; and (4) appropriate courses of college grade for adults. Integrated courses in biological and physical science are suggested.

106. Jarvie, L. L. "A Pattern of General Education in Technical Institutes," *The Journal of General Education*, I (April, 1947), 224–231. [Associate Commissioner of Education, The University of the State of New York.]

Criteria are presented for the development of general and technical courses for general education. The integration of general and technical education into a pattern of common education for a particular student is based on six basic ideas or concepts in modern science and technology, seven in social science, seven in communication, and two in personal and community health. These concepts are listed. Four comprehensive general courses are offered: Science and Technology; The Modern Community; Communications Skills; and Personal and Community Health.

107. Johnson, B. Lamar. "The California Study of General Education," *California Journal of Secondary Education*, XXV (October, 1950), 341–346. [Dean of Instruction at Stephens College and Director of the California Study of General Education.]

This report of a study financed by the Carnegie Foundation for the Advancement of Teaching presents excerpts from *Problems and Proposals Concerning General Education in California Junior Colleges*. Developing from the study will be a volume *General Education in the Junior Colleges of California*. Considered are: (1) the background and scope of the study; (2) the goals of general education, including thirteen areas most of which science

* References 9, 22, 23, 24, 25, 49, 60, 62, 63, 64, 77 and 80 consider history of science to some extent.

can help the student increase his competence in; (3) avenues to general education (five are recognized); (4) ten types of activity for participants in the study; and (5) fifteen problems to which answers will be sought. This pioneer study will apparently provide direction to all who are developing programs of general education, hence any volume emanating therefrom should be widely used.

108. Johnson, B. Lamar. "Next Steps in the General Education Study," *California Journal of Secondary Education,* XXVI (January, 1951), 47–52.

This is a report at the mid-point in time in the General Education Study in the California Junior Colleges of six significant problems. Paraphrased, the general education program must (1) begin with the student; (2) be based on the characteristics of the student and on the society in which the student lives; (3) be a college-wide program which must include all fields of instruction, extra-class activities, guidance, and work-study programs; (4) provide particular courses designed to achieve specific goals of general education; (5) secure participation of students in building the program; and (6) consider the junior college-university relationship.

109. Johnson, B. Lamar. "General Education in the Junior College," *The North Central Association Quarterly,* XXIV (April, 1950), 357–363.

Means of overcoming three obstacles—the university halo, the vocational urge, the tradition of verbalism—are given.

110. Koos, Leonard V. *Integrating High School and College: The Six-Four-Four Plan at Work.* New York: Harper and Brothers, 1946. Pp. vi+208. [Editor, *The Junior College Journal* and formerly Professor of Secondary Education, University of Chicago.]

Chapter V includes a description of the four-year junior college (grades 11–14, inclusive) in the Pasadena, California, school system. The concluding chapter should also be read.

111. Medesker, Leland L. "What Does Industry Want from the Junior College?" *The Journal of Engineering Education,* XL (June, 1950), 623–628. [Dean, Wright Junior College, Chicago.]

A faculty member of Wright Junior College, Chicago, released to spend most of one semester in eighteen industrial plants, found that industrialists wanted persons with good possibilities for promotion to the job of supervisor and foreman to secure training in three areas: (1) general education—40 to 70 per cent of the total curriculum; (2) guidance—a rigorous vocational counseling service; (3) a technical background that is broad and general but built along simple lines. In addition to separate years of general college chemistry and physics, a curriculum initiated in 1949 included basic courses in organic and inorganic chemistry, applied physics, applied mathematics, report writing, personnel management, psychology, industrial techniques, and year courses in general social science, humanities, and biological science.

112. Van Deventer, William C., *et al.* "Progress Report of the Committee on Research in Junior-College Science," *Science Education,* XXXIV (April, 1950), 185–186. [Committee on Research in Junior-College Science, National Association for Research in Science Teaching.]

The problems of junior colleges and four-year colleges with respect to science were found to be the same except that junior colleges placed a greater emphasis on matters of selection and utilization of subject matter, securing adequate teaching personnel, determining the relation of the first-level course to other science courses, and meeting transfer requirements. [See references 10, 11, 12, 17, 18 and 152.]

PRE-PROFESSIONAL SCIENCE

113. Eckles, Robert B. "Liberal Science at Purdue: An Experiment," *The Journal of General Education,* III (July, 1949), 313–316. [Acting Director of the Liberal Science Program, Purdue University.]

As a result of the success for nine years of the general education courses in physics, chemistry, mathematics, biology and psychology offered in the Liberal Science Curriculum, that curriculum will be made a proving ground for general education courses, science and non-science, that may be introduced in the School of Science. This is an approach for bringing general education courses to an institution devoted to specialization in limited areas of engineering and science.

114. Finch, James Kip. "Engineering and the Liberal Arts," *The Journal of General Education,* II (July, 1948), 301–307. [Dean of the School of Engineering, Columbia University.]

Finch presents reasons why a place must be found for general education in an already overcrowded engineering curriculum. One approach is to add general education, retain the old four-year program, and grant the bachelor's degree at the end of five years. A second approach is to make room in the four-year degree program for the general education subjects by omitting or curtailing "application" courses and training in skills which can be better learned through apprenticeship. Such courses as those in Contemporary Civilization, English, and Humanities should be offered in the liberal arts college so that students may become familiar with how the minds work of those who specialize in the disciplines.

115. Fisher, John J. "General Education in Relation to Premedical Education," *Science Education,* XXXIV (March, 1950), 126–137. [Assistant Professor of Biology, Manhattan College, New York.]

The author tabulated science courses suggested by liberal arts colleges in their premedical curricula and the entrance requirements of medical schools. He reviewed the opinions of

others with regard to medical education and then proposed that a premedical student complete 68 semester hours of prescribed courses, 48 in general education and 20 in the specialized sciences. The premedical science curriculum would include 8 semester hours of general biology, 4 of physical science, 8 of general chemistry, 4 of organic chemistry, and 8 of general physics.

116. Gregg, Alan. "General Education in Preparation for Medicine," *The Journal of General Education,* II (January, 1948), 91–95. [Director of Medical Services for the Rockefeller Foundation.]

The prospective medical student should secure considerable general education before he begins to spin his professional chrysalis about him in the usual isolation of his medical school. Gregg remarks that the premedical years are the only years available to deepen the doctor's understanding of himself, his patients, and the world; that a general education and cultural background are what the laymen would like to see in their doctor; and that the doctor must be broadly informed to manage the family as well as the patient.

TEACHER EDUCATION

117. Anderson, Paul Russell. "The Preparation of the Teacher in General Education," *The Journal of General Education,* III (January, 1949), 98–106. [President, Pennsylvania College for Women.]

General education is an all-college enterprise. The graduate school should develop an organized training program for college teachers—a program to broadly train specialists—with a supervised period of in-service teaching.

118. Eckert, Ruth E. "Some Neglected Aspects in the Preparation of College Teachers," *The Journal of General Education,* III (January, 1949), 137–144. [Professor of Higher Education and Coordinator of Educational Research, University of Minnesota.]

One of the major values of this article is in the presentation of what the University of Minnesota has done in the introduction of courses, seminars, and internships developed around teaching problems. A well-integrated basic course in higher education extends through three quarters. Carefully supervised junior instructorships are available in the general studies program of the College of Science, Literature and the Arts.

119. Eckert, Ruth E. "A New Design for the Training of College Teachers," *Junior College Journal,* XVIII (September, 1947), 25–33.

An excellent statement which should be read by deans of graduate schools and others who have responsibility for such programs.

120. French, Sidney J. "Educating the College Teacher of Science," *The Journal of General Education,* III (January, 1949), 87–97. [Dean of the Faculty and Director of the Division of Natural Science, Colgate University.]

It is suggested that the problem of general education in science be met not through specialization in general science but through greater generalization of special science. A plea is made for "trial-teaching" done in a science course in general education coincident with a seminar on the problems of higher education.

121. Lark-Horovitz, K. "Science for the Non-Scientist," *Main Currents of Modern Thought,* Fall 1949 Issue. (From a reprint, four pages.) [Head of the Department of Physics, Purdue University, and a member of the Executive Committee of the American Association for the Advancement of Science.]

A paper presented at a Symposium on Science in General Education sponsored by the A.A.A.S. Cooperative Committee on the Teaching of Science and Mathematics.

The teacher in a general education course should not be specialized in one field alone, must have a clear understanding of the connection between the natural sciences, and must have some background in the history of science and in natural philosophy. In-service training, using teachers' workshops and seminars, is advocated. Our adult population, as well as our faculty and the specialist, must be educated to recognize the importance of science in general education.

122. McGrath, Earl J. "The Education of College Teachers," *The Journal of General Education,* III (January, 1949), 83–86. [U. S. Commissioner of Education.]

A stimulating editorial.

123. McGrath, Earl J. "Teachers of General Studies," *The Journal of General Education,* I (January, 1947), 83–85. [Dean of the College of Liberal Arts, The State University of Iowa.]

An improved graduate program for prospective teachers of general courses is considered.

124. Payne, Fernandus. "Teaching of Science at the College Level," *Science,* CXI (June 2, 1950), 589–594; also *American Association of University Professors Bulletin,* XXXVI (Autumn, 1950), 497–510. [Professor of Zoology and formerly Dean of the Graduate School, Indiana University.]

Opinions which should be considered by those planning doctoral programs for the training of college teachers of science for general education.

125. Stickler, W. Hugh. "Research in Science Teaching," *Science Education,* XXXI (October, 1947), 228–231. [Stephens College.]

Suggestions given for research in the area of science in general education relate to the breadth of training of the teacher; the place of laboratory work; the responsibilities of the teacher in the Atomic Age; the responsibilities of universities for offering teachers courses in recent developments in science; and the readability of textual materials.

126. Watson, Bernard B. "Current Trends in the Training of College Teachers," *American*

Journal of Physics, XVIII (December, 1950), 553–556. [Specialist in Physics, U. S. Office of Education.]

A presentation of innovations to improve the teaching ability of those who receive the Ph.D. degree and plan to make their careers in the academic field. Discussed are: the annual Conference on the Preparation of College Teachers (Chicago); the programs in operation at Pennsylvania State College, California Institute of Technology, and Harvard University.

127. Zetler, Robert L., and W. George Crouch. "The Graduate School in General Education," *The Journal of Higher Education*, XXI (May, 1950), 239–242. [Chairman of the Department of English, Pennsylvania College for Women; Professor of English, University of Pittsburgh.]

It is suggested that, in addition to training in factual material, prospective college teachers be screened for abilities, attitudes and intended careers, and also be trained in correlation techniques, teaching methods, and the general principles of philosophical thought. Graduate courses should be designed to indicate relationships between the branches of knowledge. It is proposed that 30 semester hours of such courses include the equivalent of 6 semester hours each in science, social studies, fine arts, philosophy and education, and that the dissertation be dispensed with.

PRE-COLLEGE SCIENCE

128. Cahoon, G. P. "Teaching of Science for General Education in the Secondary School," *School Science and Mathematics*, XLIX (April, 1949), 281–288. [Professor of Science Education, Ohio State University.]

This paper was presented as a part of the Third Annual Forum of the AAAS Cooperative Committee on the Teaching of Science presented under the title "Problem of Science in General Education." Many of the ideas can be used at the college level. The paper will also orient the college teacher to the types of high-school programs through which his students have passed.

129. Douglass, Harl R. (Editor). *Education for Life Adjustment*. New York: The Ronald Press Company, 1950. Pp. viii+491. [Dean of the College of Education, University of Colorado.]

There is much reason to believe that a carefully planned arrangement comprising the best elements of the field covering approach, of the generalization approach, of the interest and needs approach, and of a functional approach will make science one of the most useful segments in providing the tools and equipment for life adjustment. Among the topics discussed are: new trends of organization and content of instructional materials in relation to biology, chemistry, physics, astronomy, geology, psychology, hygiene and sanitation. Also considered briefly are: general philosophy of the function of science, objectives, scientific method, scientific attitudes, history of science, and laboratory work.

130. Laton, Anita Duncan, and Samuel Ralph Powers. *New Directions in Science Teaching*. New York: McGraw-Hill Book Company, Inc., 1949. Pp. xi+164. [Professor of Health and Hygiene, San Jose State College; Head of the Department of Natural Sciences, Teachers College, Columbia University.]

Many of the promising innovations at the secondary-school level may furnish a kernel for germination at the college level. A unit on "The Life Span" developed in a college freshman class at Colorado State College of Education included sections on heredity, fertilization, prenatal, childhood, youth, adulthood, and senescence—what to expect, adjustments that must be made, and changes in social relationships that occur.

131. Miles, Vaden W. *Principles and Experiments for Courses of Integrated Physical Science*. Ann Arbor, Michigan: Edwards Brothers, Inc., 1950. Pp. vii+430. [Physics Department, Wayne University.]

Increasingly greater numbers of students enrolling in colleges will have had in high school an integrated course of physical science in which selected subject matter from the fields of physics, astronomy, meteorology, chemistry, and geology is unified. College teachers of physical science for general education will later need to adapt their courses accordingly. Principles are ranked in descending order of importance for such a course. Under each principle, the experiments from the different sciences are ranked in descending order of value for the course and the inductive development of the principles. The technique has implications for college science courses for general education.

132. Morse, Stanley W. "High School Science Experiences of 506 Non-Science Curricula College students," *Science Education*, XXXIV (March, 1950), 117–126. [Chairman of the Division of Science, San Francisco State College.]

In order to plan a revision of the basic science courses required of all students for graduation from San Francisco State College, an analysis was made of the high-school science courses taken in grades 9, 10, 11, and 12. A summary of one of fourteen excellent tables showed that of 506 students 37.0 per cent had none or only slight (general science) biology study; 32.4 per cent, none or only slight physical science study; 40.1 per cent, none or only slight chemistry study; 68.6 per cent, none or only slight physics study; and 58 per cent had no course that included earth science. These facts indicated that the students needed both biological science and physical science in their college programs.

133. Richardson, John S., and G. P. Cahoon. *Methods and Materials for Teaching General and Physical Science*. New York: McGraw-Hill Book Company, Inc., 1951. Pp. viii+485.

Many laboratory experiences which are suitable for physical science for general education at the college level are given in detail.

GENERAL READINGS

134. Alexander, W. Boyd. "General Education in a Work-Study Plan," *The Journal of General Education*, I (July, 1947), 287–294. [Vice-President and Dean of Administration, Antioch College.]

Antioch College was the pioneer and after twenty-five years is probably still the leader in using a work-study plan for general education. Experiences of Antioch students are used to illustrate the contributions which the work-study plan makes to the general education of a student.

135. American Council on Education. *Cooperation in General Education: A Final Report of the Executive Committee of the Cooperative Study in General Education.* Washington, D. C.: American Council on Education, 1947. Pp. xvii+240.

The ACE has released this volume and three other more specialized reports: Dunkel's *General Education in the Humanities*, Levi's *General Education in the Social Studies*, and Brouwer's *Student Personnel Services in General Education.*

136. Anonymous. "Curriculum Innovations in General Education," *Higher Education*, VI (October 15, 1949), 41–42, 48.

Science in General Education [see reference 64], *Social Science in General Education* (1948), *The Humanities in General Education* (1949), and *Communication in General Education* (1949), edited by Earl J. McGrath. Dubuque, Iowa: Wm. C. Brown Co. [Paper, $3.25, $2.50, $3.25 and $3, respectively. Price for set of 4, $11.]

137. Eurich, Alvin C. (Chairman of the Yearbook Committee). *General Education in the American College*, Part II of the ThirtyEighth Yearbook of the National Society for the Study of Education. Bloomington, Illinois: Public School Publishing Company, 1939. Pp. xii+380.

This early book in the field treats extensively general education in professional education: medical, legal, engineering, architecture, business administration, nursing, social work, teacher education. There is an appraisal of some experiments in general education.

138. Griffith, Coleman R. "The Administration of General Education," *The Journal of General Education*, I (January, 1947), 151–155. [Provost, University of Illinois.]

A discussion of a plan for the administration of three types of general education: the terminal type; the germinal type, designed to develop abilities that might be applied to almost any sort of subsequent specialization; and the cultural type. The horizontal organization of subject-matter required by general education calls for a horizontally organized educational task force which should be given both administrative and budgetary authority to get jobs done in a program of general education.

139. Heiss, Elwood D., Ellsworth S. Obourn, and Charles W. Hoffman. *Modern Science Teaching.* New York: The Macmillan Company, 1950. Pp. viii+462. [New Haven State Teachers College; John Burroughs School, Clayton, Missouri; Temple University.]

Though written for grades 1–12, there is much of value for grades 13 and 14 in chapters dealing with such topics as: developing a point of view, the major goals, method, collecting evidence, evaluation, sensory aids, and the psychology of science teaching.

140. "Higher Education, the Fortune Survey," Supplement to *Fortune*, XL (September, 1949). Pp. 1–16.

This survey is one of the climate in which higher education in America must subsist. It is imperative that aspects of this climate be considered in the development of programs of science for general education. Only 7 per cent of the respondents thought of any of the natural sciences as a requirement for boys; only 3 per cent for girls. As concluded in *Fortune*, "One safe conclusion to be drawn from the Survey is that the country needs a lot of education about higher education." Perhaps it is equally true that administrators, scientists, parents, teachers, and students need a lot of education about general education and science for general education.

141. Hughes, James M. "Patterns for General Education," pp. 34–39. *The American Association of Colleges for Teacher Education, Third Yearbook, 1950.* New York: State Teachers College, Oneonta, New York, 1950. Pp. 1–234. [Dean of the School of Education, Northwestern University.]

Observations of a Dean on four general education courses at Northwestern University: Bases of Social Life, An Introduction to the Sciences of Human Behavior, Modern Society, and Basic Science. [See reference 43.]

142. Johnson, Philip G., W. Edgar Martin and Willis C. Brown. "Selected References on the Teaching of Science," Circular No. 308–II. Washington, D. C.: Office of Education, 1949. Pp. 6. [Specialist for Science; Assistant Specialist for Biological Science; Assistant Specialist for Aviation.]

A bibliography with annotations of professional books and yearbooks which may serve as sourcebooks for those who are adapting their courses for general education and for the training of potential scientists.

143. Lyons, William Nelson. "A Further Bibliography on General Education," *The Journal of General Education*, IV (October, 1949), 72–80.

Two hundred thirty-seven references are grouped under one of the following: general readings, issues involved, content, instructional methodology, organization. This bibliography supplements the one published by Earl J. McGrath in 1940.

144. McConnell, T. R. "Fundamental Decisions in Developing a Program of General Education," *The Educational Record*, XXIX (April, 1948), 123–136. [Chancellor, University of Buffalo.]

McConnell's experience at the University of Minnesota over a period of years has caused him to make a few fundamental suggestions: (1) Clearly define the ground on which to proceed before beginning to outline courses; (2) Determine criteria for course content; (3) General education, as education for living, and special education should proceed simultaneously.

145. McGrath, Earl J. "A Bibliography in General Education," *The Educational Record,* XXI (1940), 96–118, and William Nelson Lyons, "A Further Bibliography on General Education," *The Journal of General Education,* IV (1949), 72–80.

This reprint of these two comprehensive bibliographies is available as one pamphlet from *The Junior College Journal,* American Association of Junior Colleges, 1201 19th Street, N.W., Washington, D. C.

146. McGrath, Earl J. "The Mission of Higher Education in the United States," *Association of American Colleges Bulletin,* XXXV (December, 1949), 487–493. [U. S. Commissioner of Education.]

If higher education is to educate the leaders of the nation and prepare citizens for life in the modern world, general education must be the essential component in the education of those who receive instruction beyond the high school.

147. McGrath, Earl J. "Teachers, Textbooks, and Tests," *The Journal of General Education,* III (October, 1948), 3–5. [Dean of the College of Liberal Arts, The State University of Iowa.]

It is suggested: (1) that in-service training of teachers be employed while waiting for graduate schools to alter their practices; (2) that historical accounts of pivotal experiments and biographies of leading scientific figures be prepared to supplement textbooks; and (3) that several institutions with well-developed programs of general education pool their resources to develop instruments for the evaluation of their programs in terms of behavior rather than of subject matter.

148. Pooley, Robert C. "Wisconsin's Program of Integrated Studies," *The Journal of General Education,* II (July, 1948), 308–316. [Professor of English and Chairman of the Department of Integrated Liberal Studies, University of Wisconsin.]

Aspects considered for this program in the College of Letters and Science are: the program of studies—humanities, social studies, science, composition; the student body; reasons for advancing an integrated program; problems of staff and administration; desired outcomes in terms of the student.

149. Stickler, W. Hugh, and James Paul Stoakes. "General Education: Answer to a Challenge," *Junior College Journal,* XX (March, 1950), 390–398. [Chairman of General Education, Florida State University.]

The cogent challenge and answer is recommended reading for all concerned with college programs of general education for the thirty per cent who go on for a second course in some one given field and the seventy per cent who do not. The statement of objectives for the general education program at Florida State University is included.

150. Tierney, Paul A. "Studies Nature of General Education," *The Nations Schools,* XXXXVI (October, 1950), 46. [Public Relations Officer, The State University of New York.]

Tierney tells how the State University of New York, a decentralized institution, proposes to begin to arrive at a sound program of general education. Regional committees include a representative of every college and institute within that region. The professors of education, agriculture, medicine, and varied technologies sit down to consider "What subjects in what fields of study should be taught to all students in all types of colleges, without regard to the vocations the students may ultimately pursue."

151. Valentine, P. F. (Editor). *The American College.* New York: Philosophical Library, Inc., 1949. Pp. xiii+575.

There are chapters on such topics as: (1) "Liberal Education and Specialization" by T. R. McConnell, Dean of the College of Literature, Science and Arts, University of Minnesota; (2) "Conflicting Theories of General Education" by Malcolm S. MacLean, Professor of Education, University of California at Los Angeles and formerly Dean of the General College, University of Minnesota; (3) "General Education Programs" by P. F. Valentine, Dean of Instruction, San Francisco State College; (4) "The Junior College" by John W. Harbeson, Pasadena City College; and (5) "The Teachers College" by W. D. Armentrout, Vice-President, Colorado State College of Education.

152. Washton, Nathan S. "A Survey of Science Courses for General Education in Colleges," *American Association of Colleges Bulletin,* XXXIV (October, 1948), 285–294. [Chairman, General Science, Rutgers University.]

This is the tabulation of replies to a questionnaire returned by 423 liberal arts colleges in 1948 with regard to the status of survey-type courses. *Summary.* The typical science course for general education is offered for two semesters and six credits. It is a non-laboratory course which may have demonstration and other visual aids. Usually three lectures per week are given by one instructor. The course is largely informative and little opportunity is given for discussion. The course may be either required or elective for all students regardless of whether they are science or non-science majors. Most courses require a textbook. In the biological sciences, the topics include protoplasm, human biology, a survey of plant and animal life, ecology, genetics, evolution, and paleontology. In the physical sciences, about 35 per cent of the course pertains to physics, 25 per cent to chemistry, 18 per cent to astronomy, and 22 per cent to geology and meteorology. [See references 10, 11 and 12 for a more extensive study.]

WORKSHOP FOR SCIENCE TEACHERS

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For some time the writer of this article has been concerned to find new and better ways to organize summer session experiences to effectively meet the needs of secondary school science teachers. Too often these teachers are faced with the alternatives of taking advanced science work directed toward expertness in a relatively narrow field or of taking a methods course primarily directed towards the needs of undergraduates. The first alternative helps the teacher meet the needs of that relatively small proportion of students who plan to specialize in the particular science which the teacher may study. The second alternative is too theoretical for the experienced teacher. Neither alternative offers much help in meeting the needs of the vast majority of high school students who will study science.

High school students need to learn to use elements of the scientific method in the solving of all kinds of problems; this is especially true in their study of science. They need to experience democratic processes in their classroom living. They need to have abundant opportunity to make observations and to experiment. Science has been defined by Conant as "that portion of the accumulated knowledge in which concepts have developed from observation and experiment, which concepts lead to further observation and experiment." They need to understand the numerous applications of science that are everywhere to be seen in both their rural and urban environment. The need to be conversant with the newer developments in both pure and applied science and to be aware of the numerous interrelations among these many branches of science. Finally they need to accept the way of science as a way of life to be followed in solving nearly every problem of our complex society.

During this past summer, at the University of Southern California, the writer had an opportunity to direct a workshop for teachers of science in High Schools and Junior Colleges. This workshop moved in the direction of meeting the varied needs of high school and junior college youth, but fell short of an ideal situation in several respects, for example, there was but one staff member to meet the varied academic and professional needs of students, laboratory facilities were limited, and the two hour time allotment was too short. It achieved considerable success in that the in-service teachers experienced a democratic way of living—they investigated and discussed the newer researches in science teaching—they enjoyed being brought up to date in their respective fields by invited specialists who donated their services—they shared their best methods with others and they explored numerous illustrations of both the study and uses of science in the Los Angeles area.

Together they considered what would be an ideal learning situation for a group of in-service science teachers by developing cooperatively a questionnaire to which they all responded anonymously. The analysis of the responses of this varied group of 34 graduates and teachers of science in High Schools and Junior Colleges sheds considerable light on the kind of summer session program which would be most significant to high school teachers. The varied background of the group is clearly evident from a glance at the range in the number of year courses in the various subjects each has taken.

Year courses in Astronomy	0– 1
Year courses in Biology	0–17
Year courses in Chemistry	0–15
Year courses in Physics	0– 5
Year courses in Geology	0– 4½
Year courses in Elementary Education	0– 6
Year courses in Secondary Education	0–15

I know of no other organization than a workshop which could provide an effective learning situation for a group with such divergent backgrounds. Science Teachers have such divergent backgrounds. Some are especially well trained in a particular branch of science but fail to recognize the role science can play in the lives of High School students. Others see the role of science in the lives of adolescents, but do not have the science background to challenge the more advanced students.

Item I. What about the workshop has been of most value to You?

In response to this question several aspects were mentioned. Twenty-six students referred to the democratic manner in which the workshop was conducted; fourteen students to the opportunity to relate graduate work directly to their teaching; seventeen students to the trips and the discussions and readings in connection with them; thirteen students to the demonstrations and experiments; six students to the lectures on the newer developments of science and four students to the all-workshop seminar discussions of science teaching.

1. Responses referring to the democratic manner in which the workshop was conducted:

a. Informal attitude which permitted meeting the various science teachers (7)

b. Meeting others with like problems and solutions for those problems (3)

c. Chance to speak to others in the same subject field (3)

d. Informal exchange of ideas with staff (2)

e. Group discussions (2)

2. Responses referring to the opportunity to relate graduate work directly to their own teaching:

a. Time to read and do things which up to this time I couldn't find time to do.

b. The reading I was able to do (3)

c. Freedom to read whatever I found —have learned many related things which I just came across (2)

Item II. In what respects has the workshop failed to meet your needs?

The diversity of responses is indicative of the varying needs of the heterogenous group present within the workshop. However, certain lacks are pointed out. These criticisms should prove especially valuable in planning for another workshop. Seven students wished more group work; seven wished more time for their individual projects; eight felt a need for more emphasis on methods of teaching, especially demonstrations; one student regretted the lack of resource people; another missed an account of methods of evaluating science teaching; six students felt time was wasted in reading and discussing professional articles; five stated miscellaneous criticisms; while seven felt it was just right.

Item III. How does your effort in this workshop compare with that in other 3 hour graduate courses? More, about the same, or less.

The students felt that their effort equalled or excelled that in other 3 hour graduate classes. Their responses: More 15; About the same 18; Less 0; Omitted 1.

Item IV. How does your gain in this workshop compare with that in other 3 hour graduate courses? More, about the same, less.

The majority felt that they had gained more than in the three hour graduate course as is indicated by their responses:

More 23, About the same 9; Less 1; Omitted 1.

Item V. What, if any, unique gain has come to you from this workshop experience? Explain.

The range of responses to this item indicate the close relationship that exists between one's background and what he will gain from a workshop. There is need for careful advisement for those considering enrolling in a workshop, especially for graduates who have not taught. Ten students gained an understanding of the similarity of problems faced by science

teachers; six grew in their understanding of science; ten have increased their sensitivity to teaching possibilities; nine indicated an appreciation of workshop methods; two indicated an appreciation of the value of trips; two have developed facility with reference materials; while two gained nothing at all unique.

1. Responses indicating an understanding of the similarity of problems faced by science teachers:

a. Similarity of teacher's problems (4)

b. Chance to sit together with others and exchange ideas (4)

c. Observation of the weaknesses and prejudices of teachers in the specialized sciences.

d. All teachers do not stress the same subject matter in science.

2. Responses indicating a growth in understanding of science:

a. A sudden realization of the overlapping and interdependence of the various branches of science.

b. Concrete information on modern up-to-date science.

c. The opportunity of sampling so many fields of science and having other science department staff taking over part of the discussion periods.

d. Better understanding and appreciation of science and the scientific method.

e. The development of a keener curiosity and a more questioning attitude.

f. Realization that there are many ways of solving a problem.

3. Responses showing an increased sensitivity to teaching possibilities:

a. Fresh outlook on the teaching of science.

b. Knowledge of a wide range of teaching possibilities.

c. A confirmation of my former conviction that there is no one right way to do a particular job. But instead as many ways as there are individuals. What better example of this is there than teaching?

d. I've been exposed to new ideas, methods, experiences, and have gathered the best into a card file.

e. Ideas from biology grouping ways of doing certain things in classroom; motivation, demonstrations, methods of presenting subject matter.

f. Many new fields of interest have been opened up.

g. Usable materials to take back to my teaching situation. (generally speaking one gets an unusable session built upon the idea of a final examination)

4. Responses indicating an appreciation of workshop method:

a. I have learned to be free in a classroom situation and know more about how to do research on projects and find materials for the project.

b. The observation of the workshop itself.

c. The workshop itself—how each person can get what he wants if he takes the time and effort.

d. Learned of democratic process in education. The freedom that was permitted in all activities undertaken by the workshop was outstanding. The instructor was in the background and allowed students to work on their own.

e. No pressure of cramming for a test has put work on a higher plane.

f. Most efficient use of each person's time for his unique problem.

g. The individual is given an opportunity to make a study of an interest which has arisen out of his experience as a teacher.

h. A chance to solve problems of my own, and to put into effect the content of the previous 38 units of education courses I've taken.

i. Chance to relate graduate work directly to teaching.

j. My first workshop will lead me to others.

5. Responses indicating an appreciation of the value of trips:

a. Enriched opportunities in trips and in talks by experts.

b. Chance to visit places of scientific interest.

6. Responses indicating increased facility with reference materials:

a. Exposure to new books and teaching aids.

b. New and varied materials have been introduced to supplement previously available material in the classroom.

c. Opportunity to catch up with articles in journals or periodicals.

d. The realization of the value of looking for techniques in the professional literature. I suppose I knew about it but never practiced it. Your selection of books and resources sold me.

Item VI. If you had it to do over again would you enroll in this workshop? Yes, No?

Most of the students would take it again. Yes 32, No 1, Omitted 1.

Item VII. Would you recommend this workshop to others? Yes, No.

Most of the students would recommend it to others. Yes 29, No 2, Omitted 3.

Why? Why not? The reasons for and against recommending this workshop to others indicate the extent to which participants really accepted and took advantage of the opportunities available in the workshop procedure. On the whole the responses indicate a keen appreciation of the particular workshop.

Item VIII. Indicate the relative value to you of the following workshop activities. With one exception, every type of workshop activity was rated of either high value or average value by more than two thirds of the students. Of the activities listed the three least worth while are: (1) Constructing demonstration apparatus, (2) Group projects, and (3) Reports in connection with trips. The six most worth while activities in order of preference are: (1) Sharing of workable ideas by workshop members; (2) Lectures, discussions, and demonstrations by resource people; (3) Trips; (4) Workshop demonstration-discussions; (5) Demonstrations by workshop members; (6) Individual projects.

The first eight items of this questionnaire refer to the 1950 workshop while the remaining items are recommendations based upon the 1950 workshop experience.

Item IX. Indicate the emphasis you think should be placed on the following activities:

With regard to every activity the students recommend about the same or more emphasis than we had this year. There should be an increased emphasis upon: (1) Sharing of workable ideas by workshop members; (2) Techniques; (3) Methods; and (4) Demonstrations by workshop members. Probably there should be an increased emphasis upon: (1) The doing of experiments; (2) Demonstrations by faculty; and (3) Work with various teaching materials.

Item X. In a future workshop, indicate the rank you would give the following items:

The students recommend these items in the following order:

1. Explaining difficult though common applications of science
2. Giving class demonstrations
3. Explaining modern ideas
4. Planning the workshop
5. Explaining fundamental concepts
6. Planning individual projects
7. Doing experiments
8. Making apparatus.

Item XI.

If experimental stations could be set up in a workshop so each class member could individually "do" each experiment, would you like the number in your field to be 0....., 5....., 10....., 15....., or more .....?

It is the consensus of opinion that from

5 to 10 such experiments would be about right. They prefer different experiments in this order: (1) Most recent and modern; (2) Difficult matter; (3) Fundamental; (4) Spectacular demonstrations; and (5) General subject matter.

Item XII. and response: To what extent should the content and activities of a workshop be organized in advance and required by a leader?

Large 2, About 50% 16, Small 16.

Item XIII. and response: To what extent should the content and activities of a workshop be planned cooperatively by the workshop members and faculty?

Large 16, About 50% 17, Small 1.

It is the consensus of opinion that from 20 to 40 per cent of the content and activities of a workshop should be organized in advance and required by the leader; and from 60 to 80 per cent of the content and activities planned cooperatively by the workshop members and faculty.

Item XIV. and response: What groups should be included in a workshop for secondary school teachers?

The workshop members decidedly favor having teachers of all of the sciences in one workshop.

Item XV. What room organization and equipment should there be for a Secondary-Junior College Science Workshop?

Ideally there should be at least two rooms available at all times to a workshop of this type. One room should provide facilities for lectures, films, demonstrations, discussions, group meetings, and library work. The other room should be a laboratory with an abundance of materials and equipment available, where there can be all kinds of experiments and projects. A special store room for special equipment and moderate shop facilities would be desirable.

Item XVI. To what extent should theories or practical classroom techniques be stressed?

1. The responses can be roughly summarized thus:

a. Theories—None 1, Little 5, Some 2.

b. Practical classroom techniques—Little 3, Some 6, Much 22.

They wish to develop practical classroom techniques appropriate for their level of teaching. To meet these needs adequately a workshop must provide a minimum staff which includes a high degree of specialism in Education, in Biology, in Physics, and in Chemistry. Each member of the staff must be concerned with General Education. With such specialists on the staff a workshop could be much larger than with a single staff member plus cooperative resource people.

Item XVII. To what extent should community resources be investigated?

The responses can be roughly summarized thus:

Little 2, Some 13, Much 17.

This phase of the workshop activities must be stressed but with the students so highly specialized it seems that it would be better to have most of the trips taken by groups rather than as a class—perhaps the entire workshop might take one or two week-end trips. Certain days could be set aside for special group trips—with groups taking trips at these times. Staff specialists could help the various groups prepare for and summarize the findings in connection with such trips.

Item XVIII. In a workshop planned and operated democratically, how can one be certain that all participate—That a few do not dominate the planning, discussions, etc.?

1. Responses indicating little concern for this item:

a. Doubt if it is desirable—let those who are leaders, lead. Each member should be sincere in his desire for benefit—if not—it is his loss.

b. What's wrong, if each one gets a chance, that's democratic. Failure to

participate is evidence of lack of real purpose.

c. Practically impossible—unless the workshop director can call those individuals aside for a few words.

d. No sure method.

e. We can't, but do you know a better system than democracy?

f. I think this year was very effective.

2. Responses indicating methods of achieving this end:

a. Well-planned, organized program—headed by the instructor; in planning everyone turn in a written plan.

b. In planning insist on and encourage everyone to take part. May even keep a record—such as, we've heard so many times from so and so, could we have something from others.

c. By instructor using an evaluation sheet determined by the class at the beginning.

d. Each individual or group should be responsible for some contribution to the workshop. With a large variety of projects or activities there is apt to be fewer opportunities for monopolizing.

e. Indicate at the beginning that plans are subject to change. This will permit avoiding or changing undesirable situations.

f. Perhaps the planning committee could draw straws as to the length of time of service—say 2 serve 1 week, 2, 2 weeks, 2, 3 weeks, etc.—thus stagger terms but fill vacancies with new persons.

g. Change all committees each week so that all might participate.

h. Rotation of chairmen and duties of individuals as projects warrant.

i. If you alternate too frequently you eliminate the continuity that is necessary.

3. Responses urging more group meetings:

a. More group meetings might help. Perhaps have certain days for certain students to report and conduct the discussion.

b. Individuals with common needs and interests work as a group.

c. Have group decision of a project with specific delegated responsibilities.

Though one fourth of the students indicate a preference for the exact type of organization we had this year in which the director felt there was far too little guidance, the majority of students recommend a little more definite organization in which planning committee members rotate so that more individuals have a chance to share in this activity, and one in which are more definitely organized, with definite responsibilities assigned by democratic processes to each individual, and with a rotation of chairmen. Two suggestions for attaining such organization are that the instructor submit a definite plan at the beginning—subject to change of course, and that an evaluation sheet be determined early the first week.

Item XVIV. Suggest any ways that you think the workshop can be made more effective?

1. Responses indicating a need for more counselling:

a. Each person talk over his plan for his work in the course shortly after the course gets underway—he would get a clearer picture of his method of procedure.

b. Tell people who do not know, how a workshop is set-up and how they may get the most good out of it.

c. Provide for quicker recognition of various goals so people with similar goals can work together more.

d. Provide better planning with more advisors.

e. At present it is very effective. Smaller groups so more can take part in discussions would be helpful for some.

f. Breakdown into specific science groups for frequent meetings with specialists to work with these groups.

2. Responses expressing a desire for greater stress on small group activity.

a. Have smaller, more homogeneous

groups, in which individuals can get time and help on personal problems from their instructor and get group action on problems of value to all.

b. Have more small group meetings.

c. Have each group intensively study two or three areas rather than broad areas.

d. Have more sharing of ideas on teaching.

e. Have less regular class work.

An over-all evaluation of the workshop volunteered by one student:

"My purpose in taking this course was to find out what are the most up to date objectives in the teaching of science and what have been the most fruitful methods of attaining these objectives.

I wanted to find out just exactly what procedures, what distribution of time and what results have been used and attained in our best high schools and by our best teachers.

I wanted to have an opportunity to discuss problems, conservative trends, radical trends and progressivism and to measure my own methods in the light of the work of other people.

Finally, I wanted to find out what are the weak and the strong points in my own methods and objectives through discussion, debate and observation, and to modify my teaching procedures accordingly.

This is my first experience with the workshop idea and I think the course has been a valuable and worthwhile experience. In fact, I do not believe any other course in education that I might have taken this summer would have been as worthwhile as this one.

The greater value of this course has been the discussion of what we as science teachers are doing and trying to do, where we have succeeded and where we have failed.

The sum total of the experiences represented in the discussions furnishes a wealth which would be difficult indeed to duplicate and this wealth has been possible through the workshop plan where it would not have been possible through the conventional course.

One of the strong points of our method (workshop) is, in my opinion, the idea of allowing anyone to advocate what he thinks is a good point, but insisting that he defend this point in the face of the most severe constructive criticism of other members. Also I like very much the idea of a student feeling perfectly free to argue any point in class without the idea in the back of his head that he is restricted because if he argues a certain way it will militate against his grade. I have had that feeling personally, more than once and it is a most irritating one.

To me, a teacher who can be convicing on this point has made his greatest contribution.

Other values which I have gotten from this workshop are the opportunities to see the set up and mode of operation of very successful schools, i.e., Manual Arts and El Segundo.

The visits to industrial plants, the Pure Food and Drug Laboratory, and the Hyperion Plant were also very valuable experiences which were facilitated through the workshop plan.

It is very logical that this course was a very satisfying experience simply because we the members of the class decided exactly the things which we wanted to do and did them.

It seems to me that when a teacher has been in service for a number of years and has been subject to the criticisms from the administration, other departments and other teachers that a workshop such as ours would be the most valuable summer time experience which he could get."

It seems clear from the above statements that the workshop can and should be improved by providing a larger staff with expertness in Education, in Biological Sciences, in Physics and in Chemistry. This staff could fill the need for more guidance,

and for more specialized help in the specialized groups. More adequate provision should be made for laboratory work, such provisions to include more adequate laboratory equipment, more scheduled class time, provision for duplication of more materials, and provision of specialists in the various sciences to supervise the laboratory work.

SUMMARY

1. That these students appreciated the democratic organization of the workshop perhaps more than any other characteristic. As one student has said, "we need to spend our time doing what we think we need to do."

2. For a workshop to most effectively meet the needs of specialized science teachers in secondary schools and junior colleges, there should be included in the staff at least four individuals, one a specialist in science education, one in biology, one in physics and one in chemistry.

3. That the specialists in biology, physics, and chemistry should take a major responsibility for (a) lectures on the newer developments in their specialized science, (b) for providing from five to ten special laboratory experiments dealing with the most recent and modern developments which all of the teachers of each specialty can do, (c) for meeting with the respective special groups to help them with their discussions, projects, demonstrations and other activities, and (d) for sharing in the planning and in the evaluation of the workshop.

4. That to a considerable extent, trips and discussions of professional reading, and of methods and techniques, should take place in interest groups rather than as an all-workshop activity.

5. That from 20–40 per cent of the content and activities of the workshop should be organized in advance and required of all students; while from 60 to 80 per cent of the content and activities should be cooperatively planned by workshop members and faculty. The part that is to be planned in advance would include an orientation to the newer advances in the various sciences and the special experiments in biology, chemistry, and physics that would be done by all the students in these respective groups.

6. There should be at least two rooms available at all times—one to provide facilities for lectures, films, demonstrations, discussions, group meetings and library work. The other should provide laboratory facilities with an abundance of equipment and materials available, where there can be all kinds of experiments and projects. At times, two or more laboratories would be desirable. There must also be provision for handling all equipment necessary.

7. Machinery should be set up to guarantee adequate guidance at time of enrollment.

8. There should be perhaps two all workshop trips. These should be scheduled on Saturdays—announced in advance and required of all students (one should come early) other trips should be planned and taken by special interest groups.